TRGRAPH

Transportation Network-Oriented Interactive Graphics Workspace

User Documentation

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The TRGRAPH workspace

Introduction to TRGRAPH

TRGRAPH is one component of the Princeton Transportation Network Model and Graphic Information System (PTNM). The PTNM is a graphics tool developed to meet the specific needs of managers in the transportation industry. The PTNM integrates network data, traffic models, and presentation graphics to aid in transportation analysis.

What is TRGRAPH

TRGRAPH, like ALKFLOW, OPTFLOW and QNET, is a Dyalog APL/W™ workspace. A workspace is a collection of operators, functions and variables, and is stored as a file with extension ".DWS".

TRGRAPH.DWS has functions and variables required for accessing, editing, manipulating, and displaying geopolitical and network data. Such data is provided as part of the PTNM in the form of text or APL-readable files. The user can also import data from a variety of outside sources. The PTNM contains geopolitical data for countries, states, provinces, Business Economic Areas, counties, Metropolitan Statistical Areas, Standard Point Location Codes, and zip codes in North America.

What TRGRAPH does

TRGRAPH provides transportation decision-makers with geographic mapping and network analysis capability. Maps of transportation networks with political boundary overlays, geographic bar and pie charts, and traffic density maps can be made using TRGRAPH.

TRGRAPH contains facilities for editing transportation networks and for importing or creating other networks. Transportation networks of the U.S., Canadian and Mexican railroad systems, the U.S. and Canadian highway systems, and the U.S. inland waterway system are available as options when licensing PTNM from ALK. In addition, users can import their data or data provided by a third party into TRGRAPH. Built-in functions are available to code important network changes (for example, a bridge collapse, track washout, or waterway blockage), and to modify the network for doing "what if" studies.

User Requirements

Most functions that constitute the PTNM model have been written in APL (A Programming Language). Some functions use external subroutines coded in C or FORTRAN. The model works on PCs running Microsoft Windows (95, 98, NT, 2000, ME and XP), and requires installation of Dyalog APL/W version 8.0 or above. A single user license for Dyalog APL/W costs approximately $2,000 and can be obtained from www.dyadic.com.

All workspace objects, namely functions and variables, and map graphics created by TRGRAPH can be printed out easily using printers accessible from the workstation.

The map graphics can also be stored as postscript files (.PS). To access and print these files, Adobe Distiller ™ is required. This application opens the .PS file and converts it to a .PDF format, which can be viewed, text-edited and printed using Adobe Acrobat ™. Both these programs belong to the Adobe Acrobat suite of products and can be obtained from www.adobe.com.

Initial Setup

Once Dyalog APL/W is installed on the PC, certain configuration changes have to be made before TRGRAPH can be used for the first time. These changes to the default settings are saved by the application and do not have to be done for subsequent uses.

Select *Configure* from the *Options* pull down menu at the top left corner of the APL window. Dyalog APL/W Configuration box appears in a separate window.

Select *Keyboard* tab. Choose "unify2us.din" from drop-down menu for Input Table File.

Select *Workspace* tab. Add <c:\ptnmw> to list of the search paths. Set maximum workspace size to 65534.

Click OK button to complete the modifications.

Create a folder on your C drive and name it PTNMW. Copy all contents from the PTNMPC installation CD obtained from ALK Technologies to this folder.

Special APL Keys

APL language uses an extended character set that include characters not printed on a standard keyboard. There are several keyboard layouts available in Dyalog APL/W. The symbols required for the TRGRAPH workspace can be generated using the Unified keyboard layout.

Each key can be used to generate four symbols by:

1. Pressing the key
2. Pressing the key + Shift
3. Pressing the key + Ctrl
4. Pressing the key + Ctrl + Shift

The first two of these generate ASCII characters as in any other Windows application. Pressing the alphabet key + Ctrl + Shift generate underlined upper-case alphabet characters, used sometimes in TRGRAPH function and variable names. The third option generates Greek characters and symbols mostly used to denote APL primitive operators. Some commonly used symbols and their keys are listed below.

Symbol	Keys
←	Ctrl + [
→	Ctrl +]
ρ	Ctrl + R
Δ	Ctrl + H
↑	Ctrl + Y
↓	Ctrl + U
ι	Ctrl + I
□	Ctrl + L

To learn more about these character sets, refer to Chapter 2 of User Guide or Chapter 8 of the Language Reference Dyalog APL/W user manual. The latter also provides detailed descriptions of all the APL functions and operators.

Loading TRGRAPH

An existing Dyalog APL/W workspace can be loaded in the following three ways:

1. Start Dyalog APL application. Select *Open* from the *File* pull down menu. A file chooser window appears and lets the user browse and select a workspace for loading.

2. Select workspace file (example: TRGRAPH.dws) from the Windows Explorer. Double click the file name to start Dyalog APL application and load the workspace.

3. Start the Dyalog APL application. The cursor is on the workspace window. All APL commands entered from this window executed immediately.

)LOAD *wsname*

   loads the workspace *wsname*.

   wsname.dws has to be present in one of the default directories specified in the Options – Configurations – Workspace tab. Since C:\PTNMW has been included in this list, and TRGRAPH.dws (along with other support files on CD) has been copied to the same folder, the user can load TRGRAPH by typing:

)LOAD TRGRAPH

Note that though APL language is case sensitive as far as identifying workspace objects (functions and variables stored in the workspace), it does not differentiate between upper and lower cases in workspace names and workspace commands. Hence, the following commands will also execute without any errors:

)load trgraph

)Load trgraph

)LoAd TRgraph

etc.

When the TRGRAPH workspace is loaded, along with the various functions and variables contained in it, a separate Mapping Window for displaying graphics appears. This window will initially be blank and its dimensions will hold the continental states in the USA by default.

When the cursor reappears in the workspace window, TRGRAPH is ready for use.

APL System Commands

APL system commands come with the Dyalog APL application and have been developed by the programmers at Dyadic Systems, as opposed to TRGRAPH functions developed by programmers at ALK.

A complete list and explanation of these system commands can be obtained from the Language Reference User Manual (Chapter 6). Here is a list of commands most commonly used by PTNM users.

)LOAD wsname – Load workspace wsname

)SAVE - Save current workspace (use with caution, all variables and functions that exist in the workspace will be saved, including large network variables.)

)SAVE *wsname2* – Save current workspace with a different name

)CLEAR - clears workspace

)COPY *wsname3 object* – copies *object* (function or a variable) from another workspace *wsname3*

)ERASE *object* – erases *object* (function or a variable) from workspace

)OFF – terminates APL session

Exiting TRGRAPH

To exit current session of TRGRAPH the user can do any one of the following:

1.)CLEAR – to exit TRGRAPH, but not APL session
2.)LOAD *anotherWorkSpace* – exit TRGRAPH and start using another workspace (eg: ALKFLOW)
3.)OFF – to exit TRGRAPH and APL
4. Click on close (X) button on the top right corner of the APL window – to exit APL
5. Select *Exit* from the *File* pull down menu at the top left corner of the APL window – to exit APL

Mapmaker

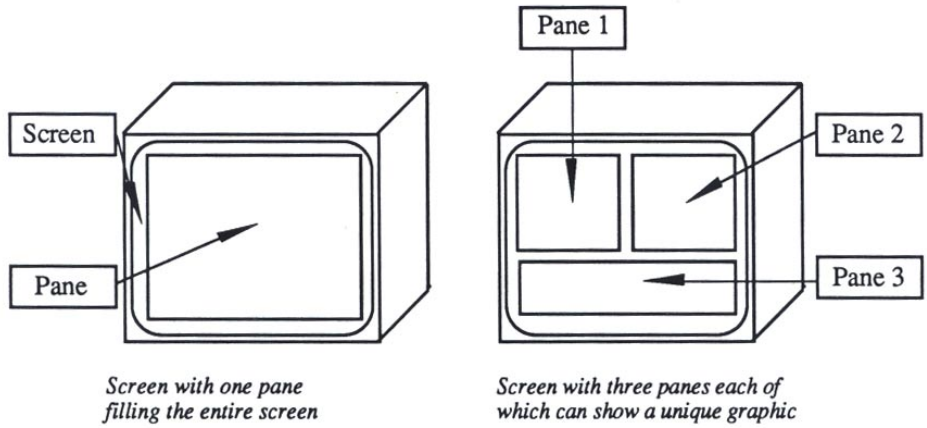
Introduction to MapMaker

MapMaker is a user-friendly tool in TRGRAPH for the creation of standard types of maps and graphs. One way to load MapMaker is by entering the command **MAPMAIN** from the TRGRAPH workspace. The other way is by selecting *MapMenu* in the *Map* pull down menu at the top left corner of the Mapping Window.

The graphics created in TRGRAPH, by MapMaker or by calling functions directly from the workspace, are displayed in a separate window called the Mapping Window. As mentioned earlier, the Mapping Window is opened when the TRGRAPH workspace is loaded. If, by accident, the user closes this window, the graphics functions will abort with error. The Mapping Window can be recreated without reloading TRGRAPH by executing the function SETΔMAPWIN.

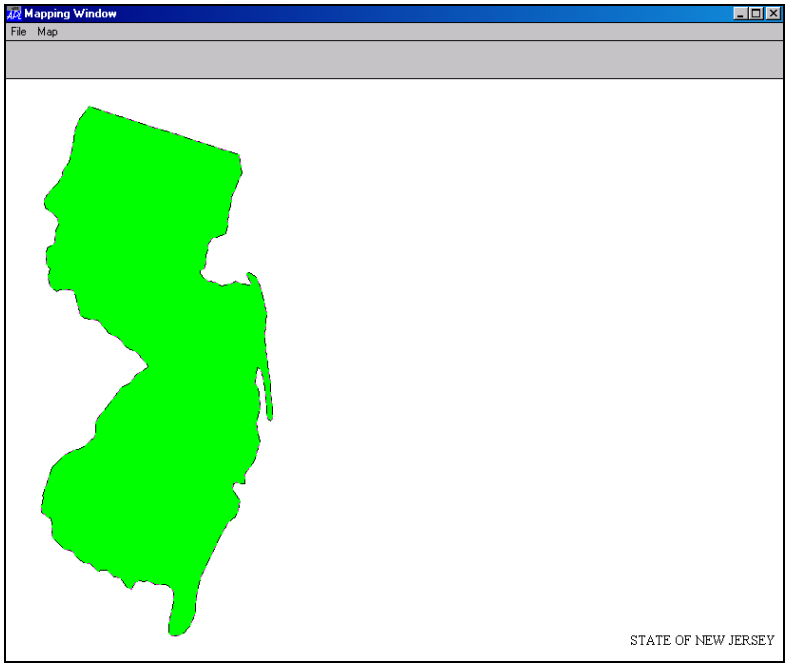
A coordinate system is a method of associating numbers with points on a surface or in space. The most commonly used coordinate system is that associated with a rectangular grid on a flat surface, such as a grid on a piece of paper or the matrix of dots on a terminal screen. These coordinates, called Cartesian coordinates (after the French mathematician, Rene Descartes), are described by a pair of numbers (x,y) which represent the offset in the horizontal and vertical directions from a certain fixed point called the origin. In TRGRAPH, your graphics screen is a coordinate system made up of units called screen coordinates. These units are called screen coordinates because they correspond to the physical makeup of the screen, either directly or through some constant ratio. In TRGRAPH, the origin of the screen coordinates is always the lower left-hand corner of the screen, and there are 1024 units horizontally across the screen. The number of units vertically will depend on the height of your particular workstation screen relative to its width.

TRGRAPH also supports a system of virtual coordinates that is related to screen coordinates through the relationship of the screen and virtual *windows.* The screen window is that portion of the screen containing the virtual coordinates. The virtual window relates the origin and range of the virtual coordinate system to the origin and range of the screen window. The illustration below shows the relationship between virtual and screen windows.

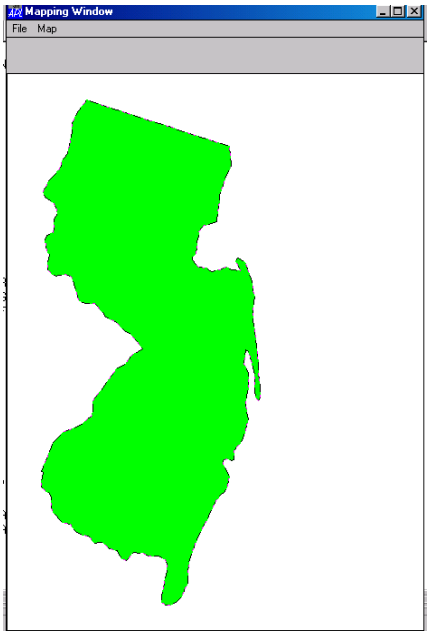

Screen
Pane
Pane 1
Pane 2
Pane 3
Screen with one pane filling the entire screen
Screen with three panes each of which can show a unique graphic

Screen window versus virtual window

The default mode for display and print of the graphics screen is Landscape. To display and print in the Portrait mode, the *flip* option is used. The following illustrates flip:

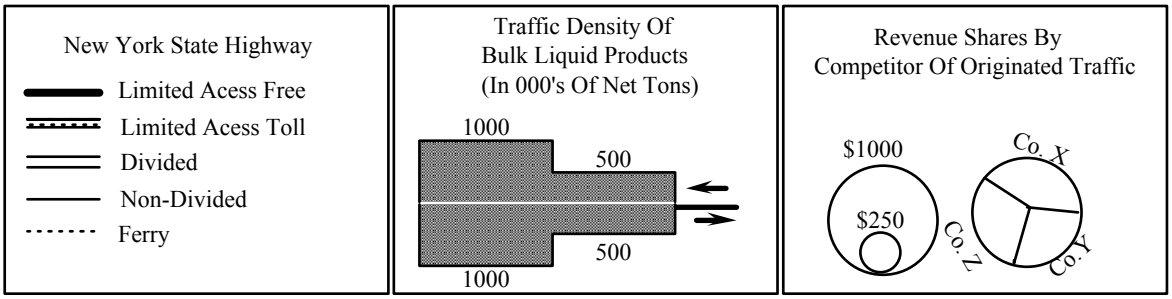


Flip = no



Flip = yes

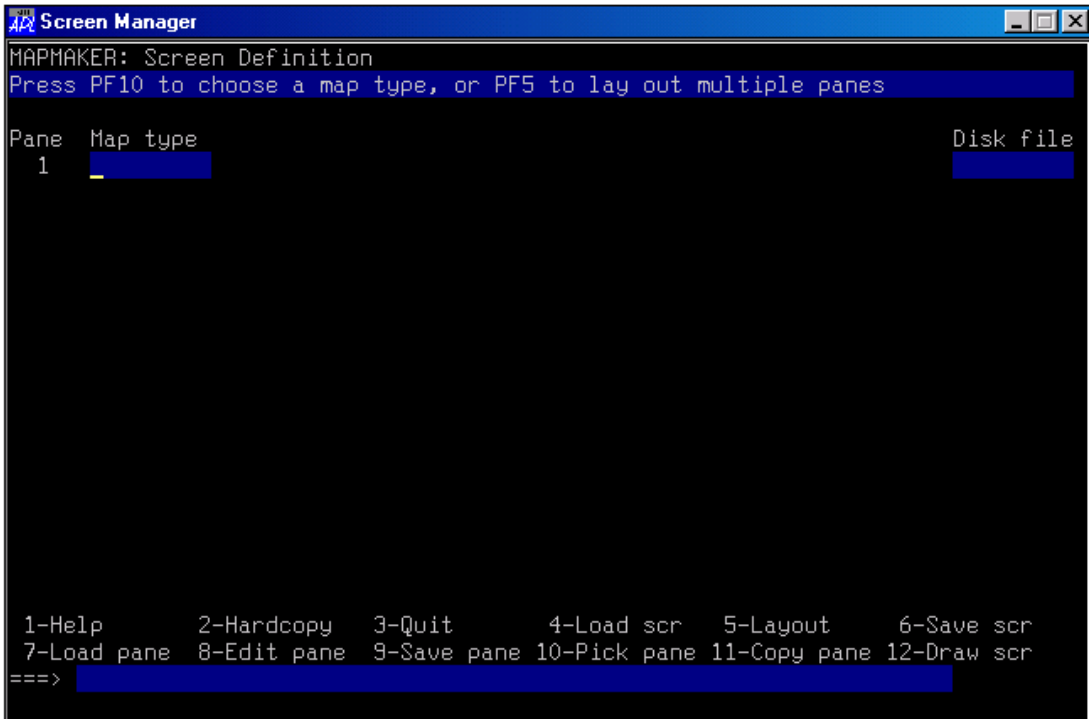
A *legend* can be drawn in each map to explain the purpose of the map and to identify the symbols used on the map. MapMaker provides a default legend that you can customize as you wish. Here are some examples of map legends.



Examples of map legends

The screen definition menu

The screen definition menu allows the user to create and customize the map and the legend. The menu looks like this:



The screen definition menu

The screen definition menu is the first menu displayed when MapMaker is invoked.

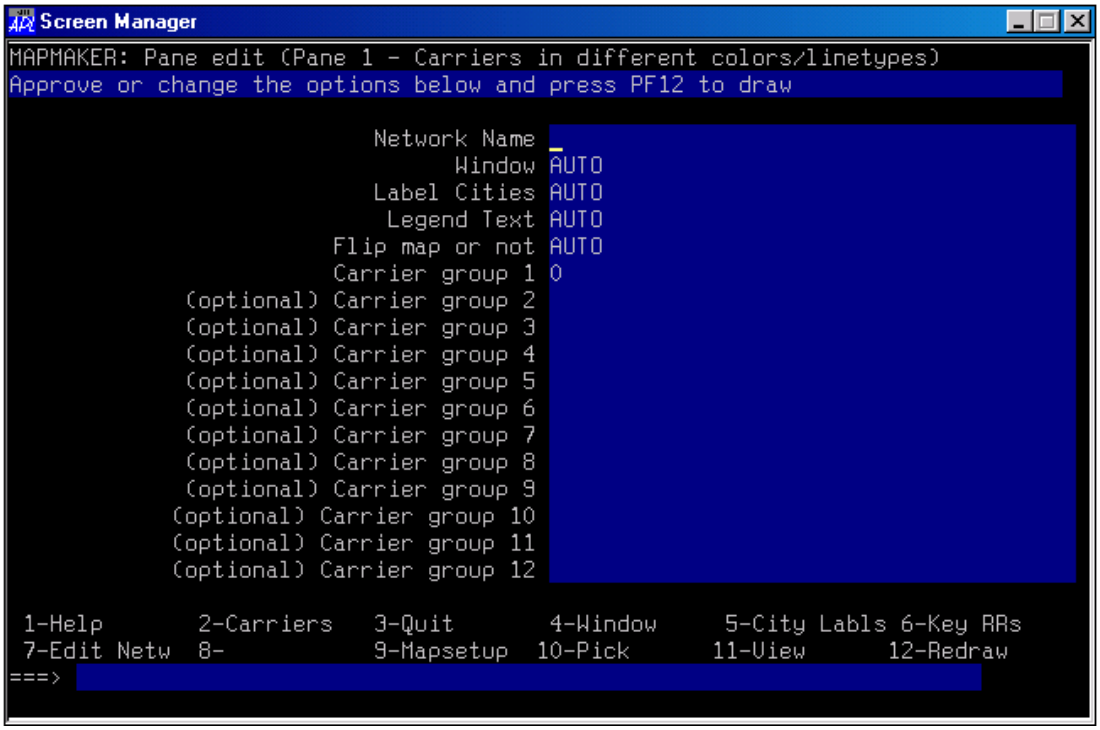
Map edit menus

Each MapMaker map or graph type has a unique map edit menu with options specific to that type.

Map edit menus also have certain general features that are common to many map or graph types. These general features will be described first, followed by the specific map edit menu for each map type.

General features of map edit menus

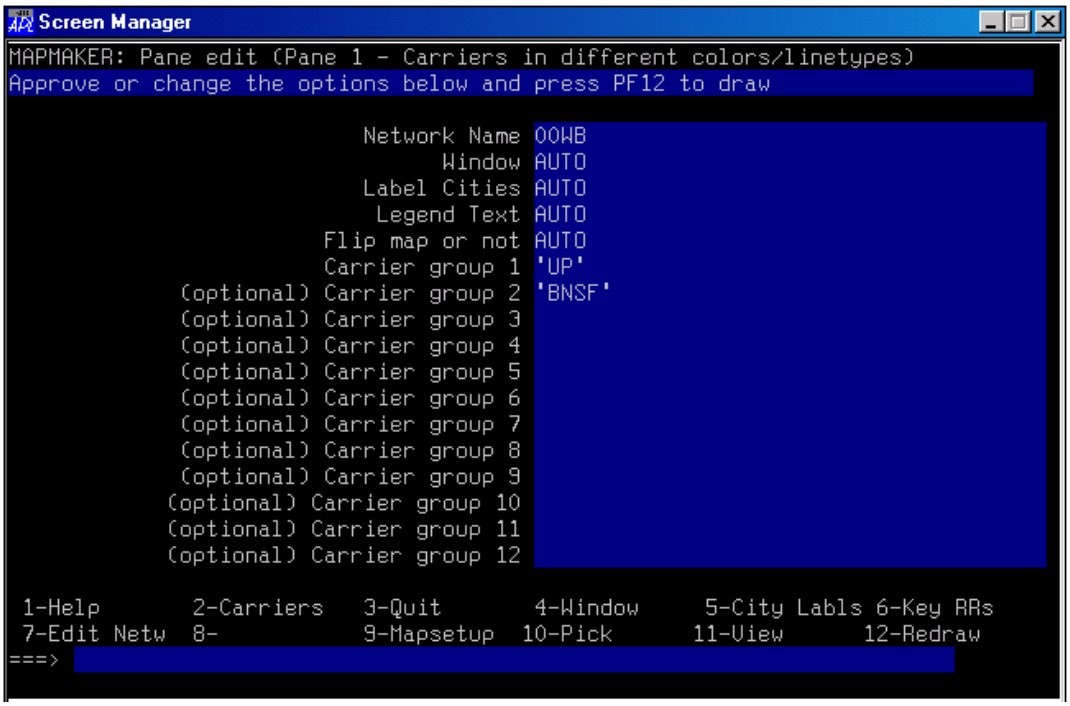
All map edit menus have certain features in common. As an example, let us look at the map edit menu for the CARRIER map type, as shown below:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Carriers in different colors/linetypes)
Approve or change the options below and press PF12 to draw
Network Name
Window AUTO
Label Cities AUTO
Legend Text AUTO
Flip map or not AUTO
Carrier group 1 0
(optional) Carrier group 2
(optional) Carrier group 3
(optional) Carrier group 4
(optional) Carrier group 5
(optional) Carrier group 6
(optional) Carrier group 7
(optional) Carrier group 8
(optional) Carrier group 9
(optional) Carrier group 10
(optional) Carrier group 11
(optional) Carrier group 12
1-Help 2-Carriers 3-Quit 4-Window 5-City Labls 6-Key RRs
7-Edit Netw 8- 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The CARRIER map edit menu

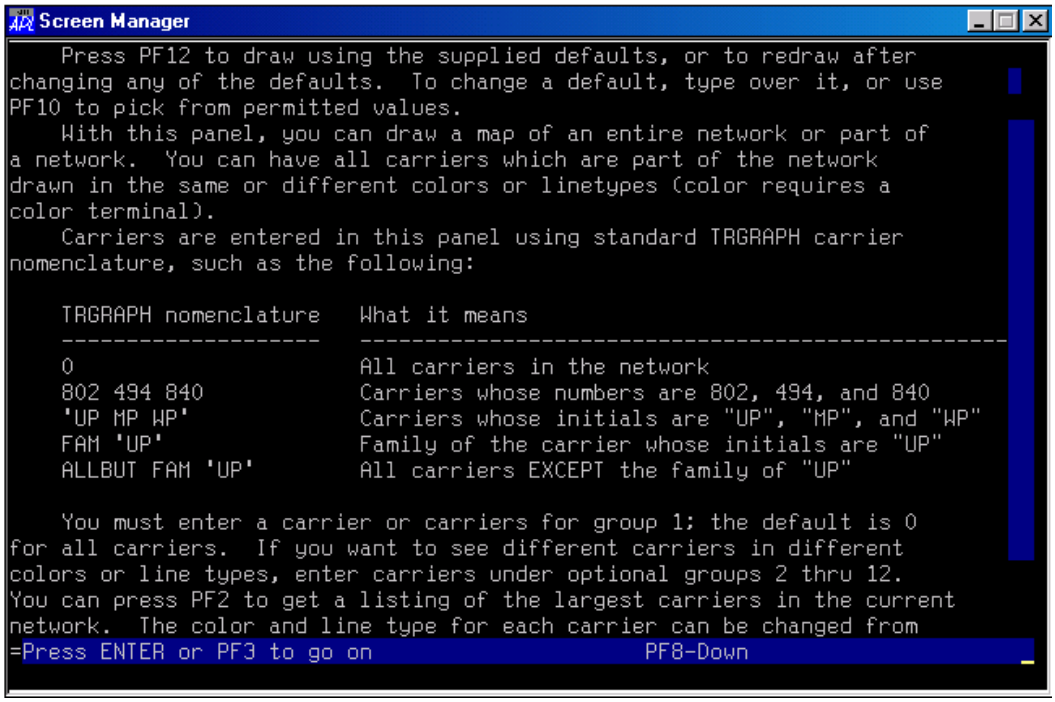
The main part of the menu is in fill-in-the-blank style. Each line of the menu contains one option parameter that you can change to control the content of the map or graph. A description of each parameter is followed by the current value of the parameter to its right. You will notice that default values have been provided for all parameters in the example of the CARRIER pane except the parameter called *Network name*. If you had chosen a network using *PICKNET* on the TRGRAPH main menu, then the name of that network would be supplied as the default for the network name.

You can examine the list of map parameters and change them to suit your needs. In the following illustration, the menu has been altered to produce a map of the Union Pacific and Burlington Northern Santa Fe railroads from the network called “00WB”:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Carriers in different colors/linetypes)
Approve or change the options below and press PF12 to draw
Network Name 00WB
Window AUTO
Label Cities AUTO
Legend Text AUTO
Flip map or not AUTO
Carrier group 1 'UP'
(optional) Carrier group 2 'BNSF'
(optional) Carrier group 3
(optional) Carrier group 4
(optional) Carrier group 5
(optional) Carrier group 6
(optional) Carrier group 7
(optional) Carrier group 8
(optional) Carrier group 9
(optional) Carrier group 10
(optional) Carrier group 11
(optional) Carrier group 12
1-Help 2-Carriers 3-Quit 4-Window 5-City Labls 6-Key RRs
7-Edit Netw 8- 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

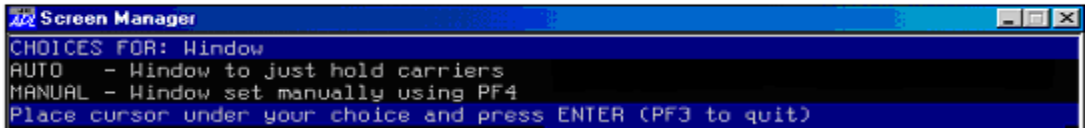
The CARRIER map edit menu altered

Several aids are provided by MapMaker to assist you in filling in or altering the parameters in the map edit menu. For example, you can press **PF1** to display a screen of basic instructions for the relevant map type. The following illustration shows the screen of basic instructions for the CARRIER map type.


Screen Manager
Press PF12 to draw using the supplied defaults, or to redraw after changing any of the defaults. To change a default, type over it, or use PF10 to pick from permitted values.
With this panel, you can draw a map of an entire network or part of a network. You can have all carriers which are part of the network drawn in the same or different colors or linetypes (color requires a color terminal).
Carriers are entered in this panel using standard TRGRAPH carrier nomenclature, such as the following:
TRGRAPH nomenclature What it means
0 All carriers in the network
802 494 840 Carriers whose numbers are 802, 494, and 840
'UP MP WP' Carriers whose initials are "UP", "MP", and "WP"
FAM 'UP' Family of the carrier whose initials are "UP"
ALLBUT FAM 'UP' All carriers EXCEPT the family of "UP"
You must enter a carrier or carriers for group 1; the default is 0 for all carriers. If you want to see different carriers in different colors or line types, enter carriers under optional groups 2 thru 12.
You can press PF2 to get a listing of the largest carriers in the current network. The color and line type for each carrier can be changed from
=Press ENTER or PF3 to go on PF8-Down

Basic instructions for the CARRIER map type

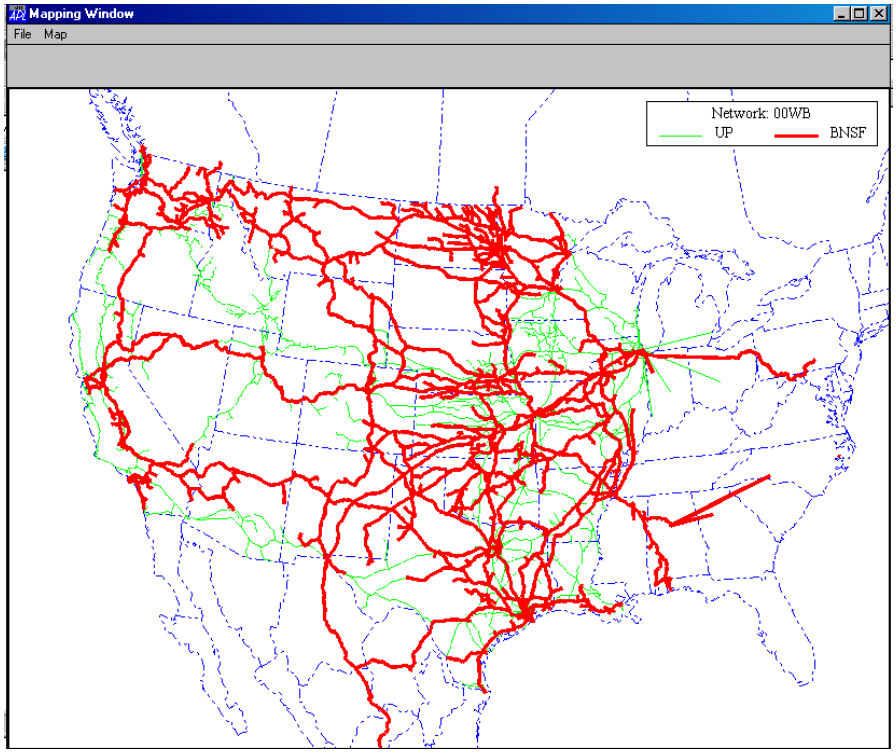
Most parameters in map edit menus have a limited set of choices. For these parameters, you can select from a list of alternatives by placing the cursor on the line for the desired parameter and pressing **PF10**. You then make your choice from the list presented. For example, in the map edit menu for the CARRIER map type, place the cursor to the right of the parameter description *Window* and press **PF10**. You will be presented with a list of choices that looks like this:


Screen Manager
CHOICES FOR: Window
AUTO - Window to just hold carriers
MANUAL - Window set manually using PF4
Place cursor under your choice and press ENTER (PF3 to quit)

List of choices for the Window option

Tab the cursor to the choice you want and press ENTER. Alternatively, you can press **PF3** to return without changing the choice that was previously made.

After you review the map options and change them to suit your needs, you can draw the map on the Mapping Window by pressing **PF12**. The map drawn by the choices in the above menu looks like this:



A carrier map of the Union Pacific and Burlington Northern Santa Fe systems

After the first drawing of the map, you may want to change more options and redraw the revised map. To do this, change the options you want and press **PF12** again. Depending on which options you changed, the map may be drawn much faster the second time. MapMaker looks at what changes you have made in the options, and only re-executes those program steps that are affected by the changed options. This enhances your productivity by reducing the computation time required when redrawing.

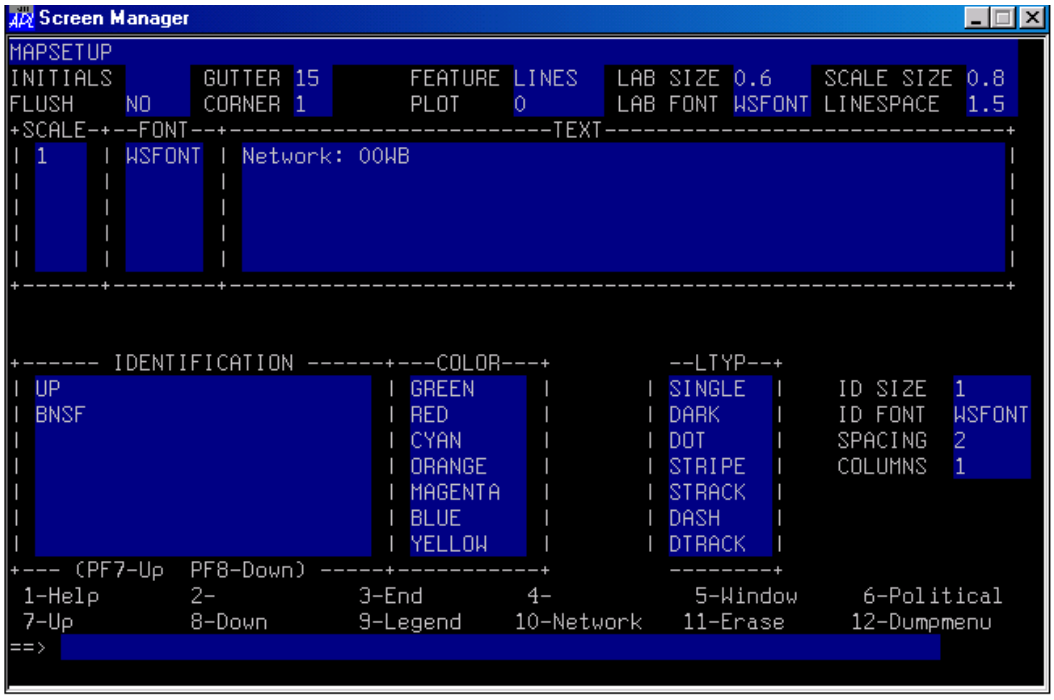
While the map or graphic is being created, certain messages may appear in the upper left-hand corner of the menu. These messages tell the user what program step is being performed at the time the message appears.

In the bottom of the menu is the command line (===>). From the command line, you can execute TRGRAPH commands or user-defined APL functions. For example, after drawing the CARRIER map, you could label 'Los Angeles CA' on the screen by entering LABEL 'LOS ANGELES CA'. When you are finished editing the map, you can return to the screen definition menu by pressing **PF3**.

Introduction to the MAPSETUP options menu

A good map or graph will include a legend that identifies its purpose and explains the symbols used. Each MapMaker pane includes a default legend, as well as defaults for map symbols such as color, shape, and size. You can customize the default legend or

change the characteristics of map symbols using the MAPSETUP options menu. The MAPSETUP options menu looks like this:


Screen Manager
MAPSETUP
INITIALS GUTTER 15 FEATURE LINES LAB SIZE 0.6 SCALE SIZE 0.8
FLUSH NO CORNER 1 PLOT 0 LAB FONT WSFONT LINESPACE 1.5
+SCALE-+--FONT--+-----TEXT-----+
| 1 | WSFONT | Network: OOWB |
+------+--------+-----+
+------ IDENTIFICATION ------+---COLOR---+ --LTYP--+
| UP | GREEN | SINGLE | ID SIZE 1
| BNSF | RED | DARK | ID FONT WSFONT
| CYAN | DOT | SPACING 2
| ORANGE | STRIPE | COLUMNS 1
MAGENTA	STRACK
BLUE	DASH
YELLOW	DTRACK
+--- (PF7-Up PF8-Down) -----+-----+ --------+
1-Help 2- 3-End 4- 5-Window 6-Political
7-Up 8-Down 9-Legend 10-Network 11-Erase 12-Dumpmenu
==>

The MAPSETUP options menu

You can invoke the MAPSETUP options menu for a pane by pressing **PF9** in the map edit menu, or by entering MAPSETUP from the TRGRAPH workspace window. In MAPSETUP, various parameters are displayed. Use the arrow keypad, the tab key, or the mouse to move the cursor to a parameter whose value you wish to change. Then type over the existing value with the new value.

If you want more information about a particular parameter, move the cursor to that parameter and press **PF1**. A brief explanation of the parameter will be displayed at the bottom of the screen.

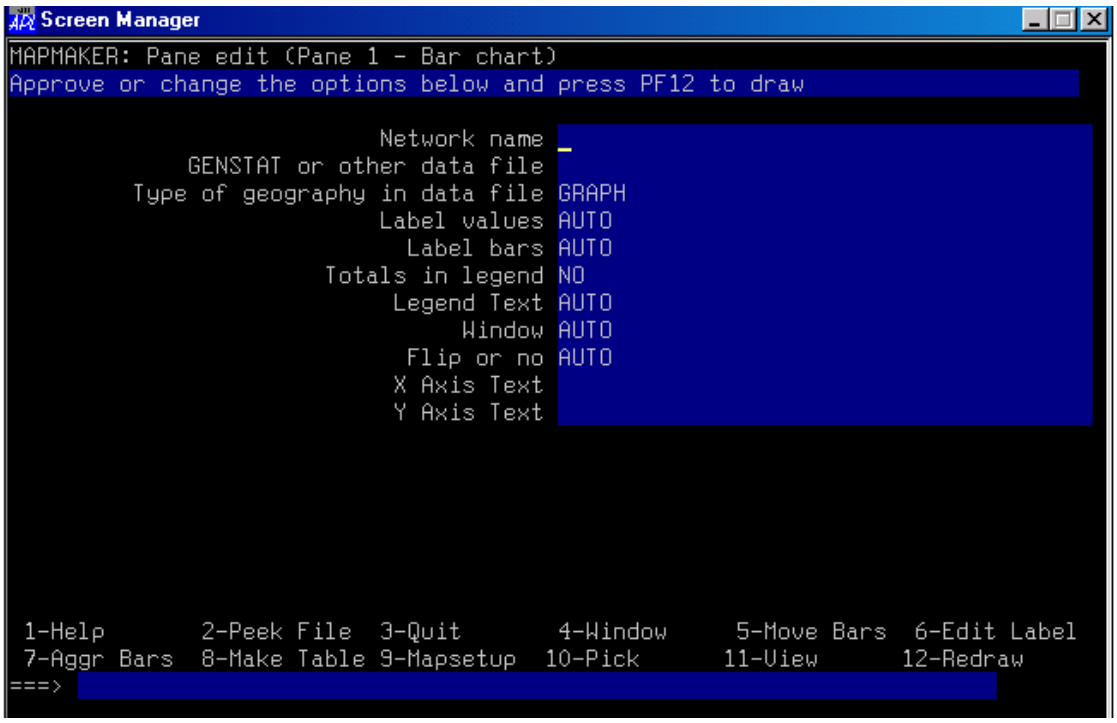
The *feature* parameter, which is at the top center in the MAPSETUP options menu, is used to alter the set of parameters displayed by MAPSETUP in order to accommodate different map types.

The "==>" prompt at the bottom of the menu indicates the command line. Any valid TRGRAPH or APL command can be executed by typing that command at the prompt and then pressing ENTER, in the same manner as the command line in the map edit menu. For example, you could draw the U.S. political boundaries on the screen by typing the word USMAP and pressing ENTER.

To exit MAPSETUP, press **PF3**. This will return you to the map edit menu. Press **PF3** again to return to the screen definition menu. The rest of this chapter will describe the map edit menu for each map type.

BAR - bar charts

The BAR map edit menu lets you create geographic or non-geographic bar charts. From the screen definition menu, press **PF10** or type the word **BAR** to select the map edit menu for a bar chart. After you select the pane, press **PF8** to edit the menu. The BAR map edit menu looks like this:

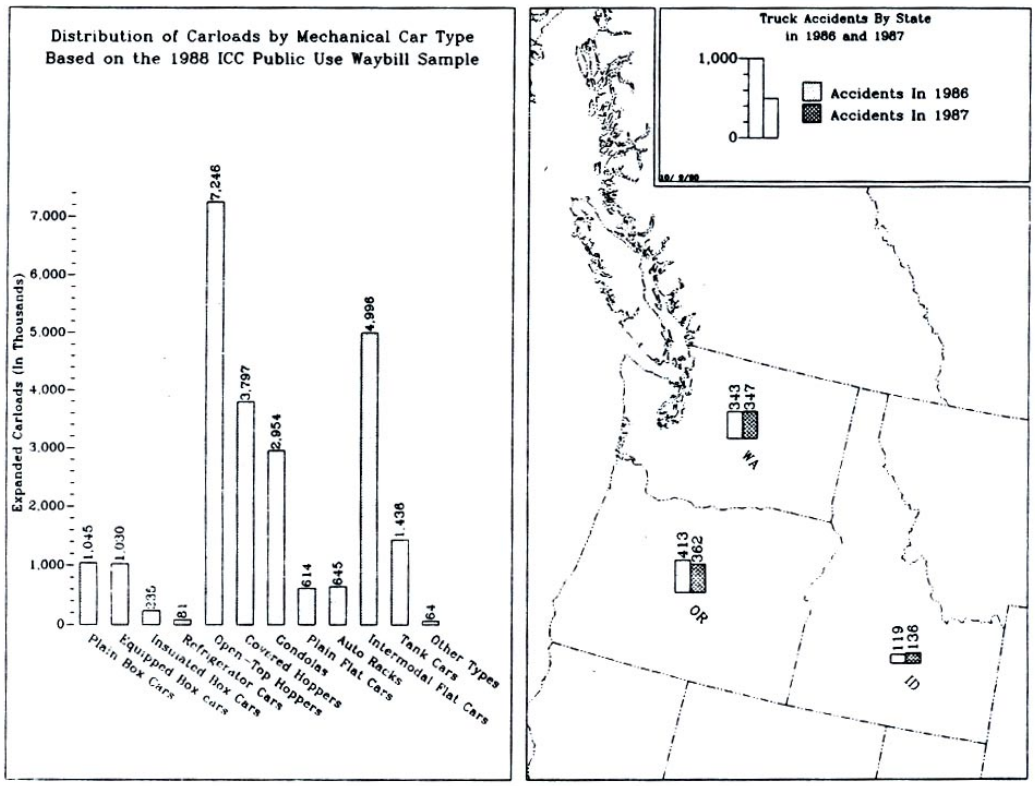

Screen Manager
MAPMAKER: Pane edit (Pane 1 - Bar chart)
Approve or change the options below and press PF12 to draw
Network name
GENSTAT or other data file
Type of geography in data file GRAPH
Label values AUTO
Label bars AUTO
Totals in legend NO
Legend Text AUTO
Window AUTO
Flip or no AUTO
X Axis Text
Y Axis Text
1-Help 2-Peek File 3-Quit 4-Window 5-Move Bars 6-Edit Label
7-Aggr Bars 8-Make Table 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The bar map edit menu

Introduction to bar charts

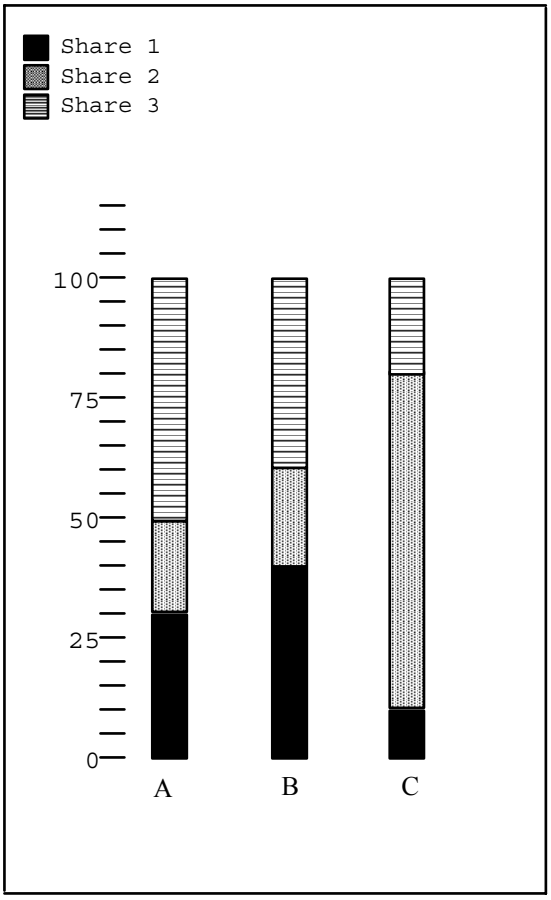
Bar charts are used to graph one or more dependent variables against an independent variable. A bar chart graphs are used when the independent values are *discrete* (as opposed to *continuous*) and are particularly well suited to graphs where the independent values are non-numeric.

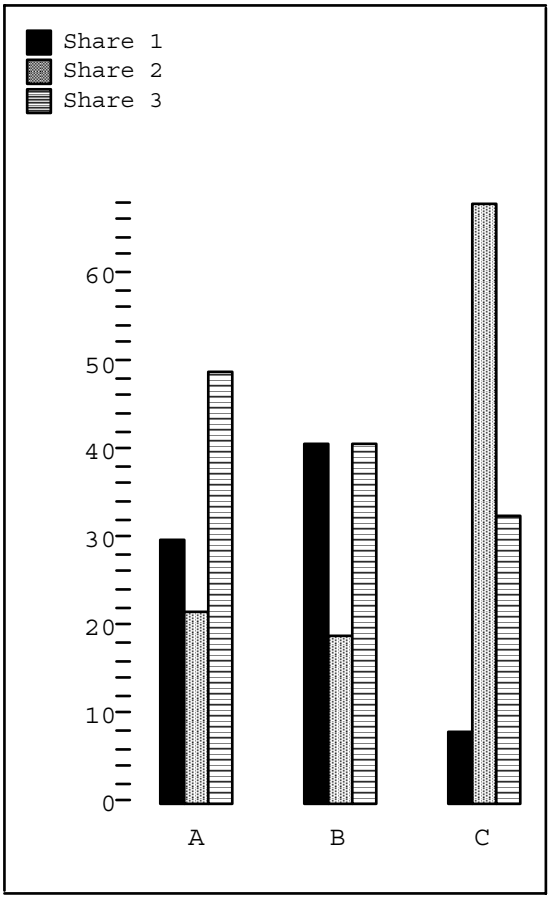
In the PTNM, bar charts may be geographic. For example, the bars may be located at cities, or at centers of states and provinces. In this case, location is the independent variable being graphed. Bar charts can also be non-geographic. In the example which follows, the pane on the left shows a non-geographic bar chart and the pane on the right shows a geographic bar chart



An example of a non-geographic bar chart *An example of a geographic bar chart*

Multiple bars may be drawn at each location (for example, to show the ratio of originating and terminating traffic), and each bar may also have shares (for example, to show market shares by carrier, or the proportion of traffic by commodity). In the example which follows, the chart on the left shows bars for values A, B and C with multiple shares and the chart on the right shows multiple bars for values A, B, and C.





Bars for values A, B, and C with multiple shares *Multiple bars for values A, B, and C*

Geographic bar charts

If your input data file contains geographic codes in the left most column, you can draw a geographic bar chart. The types of geography MapMaker supports are as follows:

• Node - Nodes are locations (such as cities, towns, or stations) on a network. They are identified by right-justified numbers from one to five digits.

• State - U.S. state, Canadian provinces, and Mexican estados are identified by 2-letter abbreviations

• FIPS - Each U.S. county is assigned a 5-digit Federal Information Processing Standards (FIPS) code. The first two digits identify the state. FIPS are maintained by the U.S. Department of Commerce, National Bureau of Standards. The FIPS option handles either 2-digit (graphed by state) or 5-digit (graphed by county) input.

• BEA - BEAs are groups of counties called Business Economic Areas as defined by the U.S. Department of Commerce Bureau of Economic Analysis. BEAs typically represent metropolitan areas and surrounding rural counties. They often include

counties in several states. BEAs are all-inclusive, unlike Metropolitan Statistical Areas (MSAs) which include urbanized areas only. Many government and private groups publish data on a BEA basis.

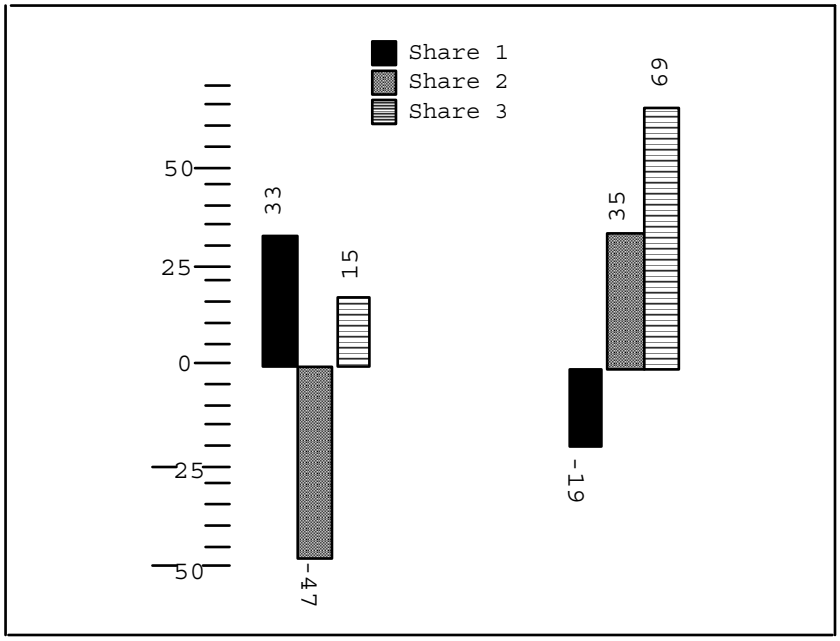
• MSA - Metropolitan Statistical Areas (MSAs), recognized by the Office of Management and Budget for Federal statistical purposes, are metropolitan areas identified by 5-digit codes.

• SPLC - The Standard Point Location Code (SPLC) as used here is a 2-digit code, which identify a state or part of a state. Data containing SPLCs of more than 2-digits can be graphed by using TRGRAPH translation functions to translate them into FIPS or Node form. SPLCs are maintained by the National Motor Freight Traffic Association.

Bar chart input data

The input needed to create a bar chart is a flat file with identifying information in the first column (node numbers, car types, state alphas, commodity codes, etc.) and quantities of information to be shown as bars (or bar shares) in the remaining columns.

For the bar chart to make sense, all quantities should use the same unit of measure. If the data contains negative values, the bars which represent those values will be *hanging*. A bar chart with some hanging bars looks like this:



An example of hanging bars

You cannot have multiple shares per bar if you have negative values in your input data.

The input data is always read from a disk file. It may be a file which is the output from another TRGRAPH function or any flat text file created by a program outside the PTNM/GIS.

Creating a basic bar chart

A bar chart can be created with the option defaults provided in the menu. Enter the full name of the text file containing the data required for the bar chart. The X-axis information is the first column and subsequent columns contain values for Y-axes. The default map type is a non-geographic bar chart. You must set the type of geography if you want to produce a geographic bar chart. Press **PF12** to draw a graph using the supplied defaults, or to redraw after changing any of the defaults. To change a default, type over it, or use **PF10** to pick from permitted values.

Choosing a geographic window

If you are creating a geographic bar chart, the default geographic window is one that just holds the locations of your data. You can manually control the window by changing the *Window* parameter to MANUAL. You can press **PF4** to select a window for your map. The choices you can select from are as follows:

- *QVWINDOW* leaves the current window unchanged.
- *ZOOM* lets you use the graphic cursors to define the window by zooming in on a map that is already drawn.
- *USWINDOW* sets the area to be shown as the U.S.
- *NAWINDOW* sets the area to be shown as North America.
- *CANWINDOW* sets the area to be shown as Canada.
- *MEXWINDOW* sets the area to be shown as Mexico.
- *STATEWINDOW* lets you select U.S. states to define the window.
- *PROVWINDOW* lets you select Canadian provinces to define the window.
- *ESTWINDOW* lets you select Mexican estados (states) to define the window.
- *CNTYWINDOW* lets you select U.S. counties to define the window.
- *WINDOW* lets you select carriers in the current network to define the window.
- *NWINDOW* lets you select a city (or cities) to define the window.
- *ADVANCE* sets the area to be shown as the center half of the current map screen.
- *RETREAT* defines the window as the current window enlarged by a factor of 2.

Re-locating or aggregating bars

After the bar chart is drawn the first time, you can press **PF5** to use the graphic cursor to shift the locations of any overlapping bars. If you have a lot of overlap, you may want to aggregate a group of bars to show the summation of them at one location. Press **PF7** to use the graphic cursor to aggregate bars.

Options on the bar chart menu

- If you are creating a geographic bar chart of type *Node*, you must enter the name of a network for the *Network name* option. Press PF10 to select a network from the list of networks available to you. You must select a rail network if you have rail node numbers in your input data. You must select a highway network if you have highway node numbers in your input data. For more information on networks, see this manual's section called "Network Mapping." If you are creating a non-geographic bar chart or a geographic bar chart of a type other than Node, you may leave the *Network name* option blank.

- Enter the name of your input data file on the menu line Data file. You may enter just the name of the file if it is in "C:\PTNMW\DATA" directory, or alternatively, enter the full file name along with the pathname and extension.

- If your input data file contains geographic codes in the left most column, you can draw a geographic map. Place the cursor on the line Type of geography in data file and press PF10 to choose the geography that matches your data. You may need to press PF2 first to peek at your data file.

- Choose ALL for the option Label Values to display the numerical value represented by each bar at the top of the bar. No bars values will be labeled if you choose NONE. The AUTO choice will label all bar values on non-geographic charts, and no values on geographic charts. If you have bars with more than one share, the value labeled will be the sum of all the shares in the bar.

- Choose ALL for the option Label bars to label the text of the bar names at the base of each bar (or group of bars, if you have multiple bars). The bar names default to the first column of the input data. No bar names are labeled if you choose NONE. The AUTO choice will label all bars on non-geographic charts and no bars on geographic charts.

- Choosing YES for the option Totals in legend will calculate the sum of the dependent values in the data and show the total in the legend. The totals will not be shown if you choose NO.

- A legend text is generated automatically. To change the text either before or after the map is first drawn, change the Legend text option to MANUAL and press the PF9 key to type in your own text using MAPSETUP. Choose AUTO to generate text automatically. No legend will be drawn if you choose NONE.

- If you are creating a geographic bar chart, the window is selected automatically. To change this either before or after the map is first drawn, change the Window option to MANUAL and press PF4 to choose a window. Choosing AUTO selects a window automatically.

- The graph is flipped using the Flip or no option. Choosing NO keeps the screen in Landscape mode. Choosing YES puts the map in Portrait mode. The AUTO choice will automatically flip or not flip the map based for geographic bar charts, based on the spatial layout of the bars.

- If you are creating a non-geographic bar chart, your text input on the menu line X-axis text will be drawn under the X axis. Your input on the menu line Y-axis text will be drawn next to the Y-axis. If you are creating a geographic bar chart, these parameters are ignored.

MAPSETUP options used in bar charts

As in the map edit menu for line graphs, **PF9** invokes the MAPSETUP options menu. You can type in your legend text in the TEXT area.

The IDENTIFICATION area in the lower left of the menu controls how the controls are labeled in the graph legend. Adjacent to the text identifying each line you can control the color and line type pattern of each line. If you have more than 8 lines, these options can be scrolled using **PF7** (up) or **PF8** (down). To change the colors of the bars, move the cursor underneath the COLOR option and type in a different color. To change the line-type pattern of the lines, move the cursor underneath the LTYP option and type in a different pattern.

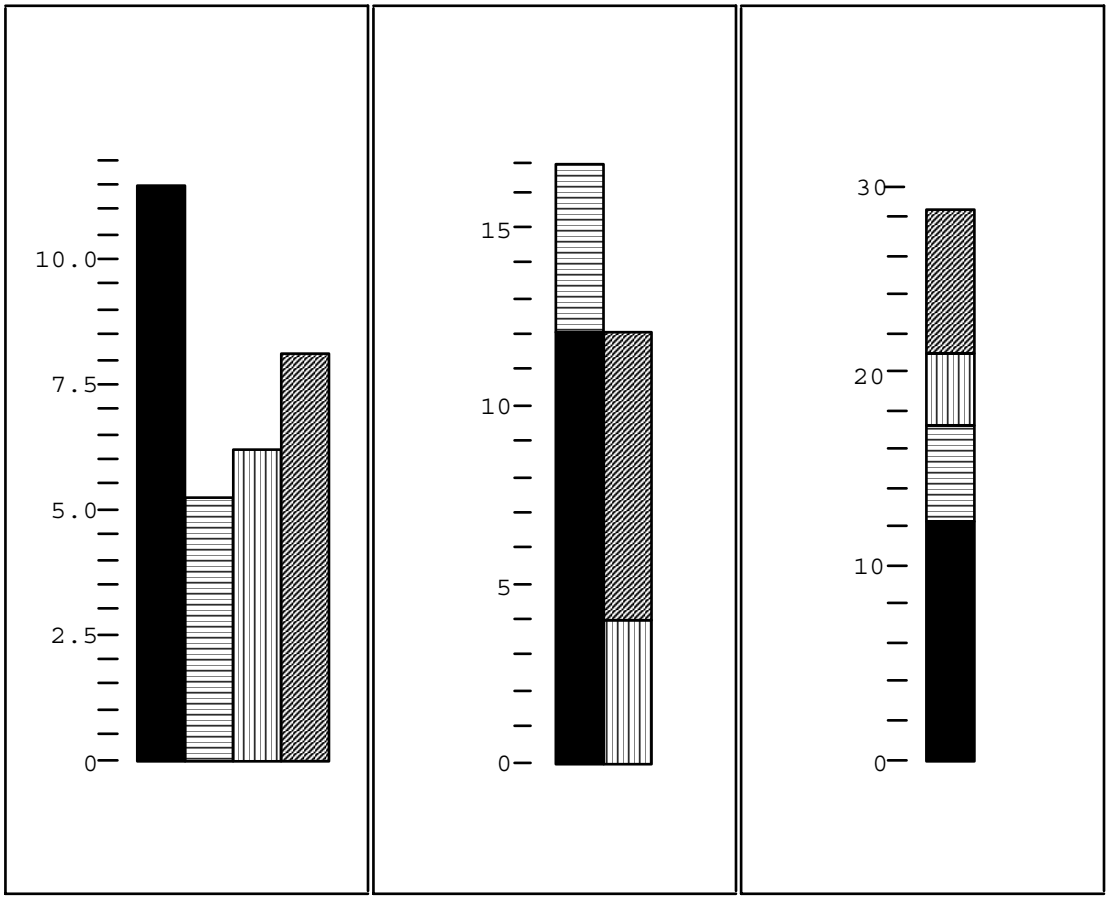
The COLUMNS option lets you determine how many columns to use to show the bar identifications. For example, if you have four different bar identifications and you set COLUMNS equal to 1, then the legend will show one column with all four bars. If you set COLUMNS equal to 2, then the legend will show two columns with two bars in each column. You can control the spacing between the bar identifications with the SPACING option.

You may need to change the FEATURE option to BAR in order to have access to the IDENTIFICATION and other options.

The DOLLAR option lets you control whether or not to place a dollar sign before the bar values on the graph and in the legend. This is handy for indicating that bar values, such as revenue, are in dollars. The size of the bar value labels is controlled with the LAB SIZE option. This size is in terms of a fraction of the standard lettering size. The font of the bar labels is controlled with the LAB FONT option.

To change bar colors, move your cursor into the COLOR option area and type in different colors. With the cursor in this area, you can press PF1 to display a list of color choices. To change the shading patterns, move your cursor into the PATRN option area and type in different pattern numbers.

The SHARES option lets you determine how many adjacent values in the input data are to be stacked as shares of the same bar. If SHARES is 1, then one bar will be drawn at each point for each value. For example, if there are four values following the location in each row of the bar chart input matrix, then four parallel bars will be drawn for each location. But if SHARES is 2, then *two* bars will be drawn at each location, each having *two* shares. If SHARES is 4, then *one* bar with *four* shares will be drawn at each location. The following illustrates this example using SHARES:



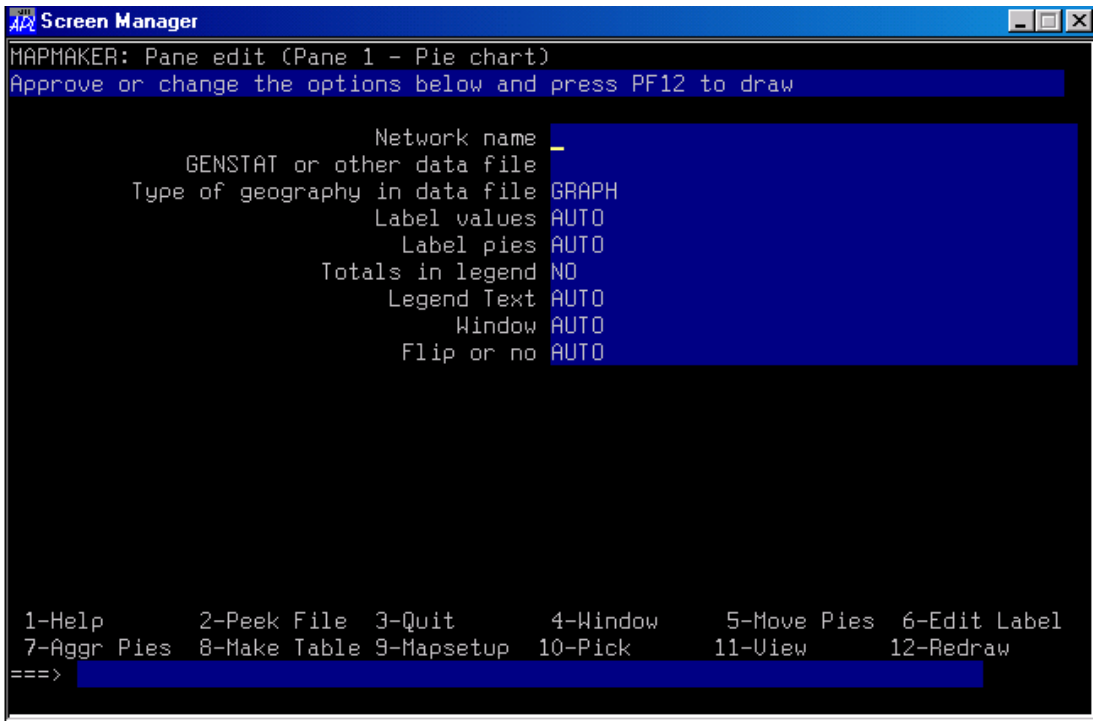
One share *Two shares* *Four shares*

The parameters HEIGHT and WIDTH control the maximum bar height and width, respectively, measured in screen coordinates. If, for example, you wanted to reduce the height of each of the bars, you would reduce the value of the HEIGHT option. If you wanted to increase the height, you would increase this value. The ANGLE option controls the angle at which the bar names are labeled with respect to the base of each bar.

If you are creating a non-geographic chart, you may have to change FEATURE to BAR to access certain fields.

PIE - pie charts

The PIE map edit menu lets you create geographic and non-geographic pie charts. From the screen definition menu, press **PF10** or type the word **PIE** to select the map edit menu for a pie chart. After you select the pane, press **PF8** to edit the menu. The PIE map edit menu looks like this:

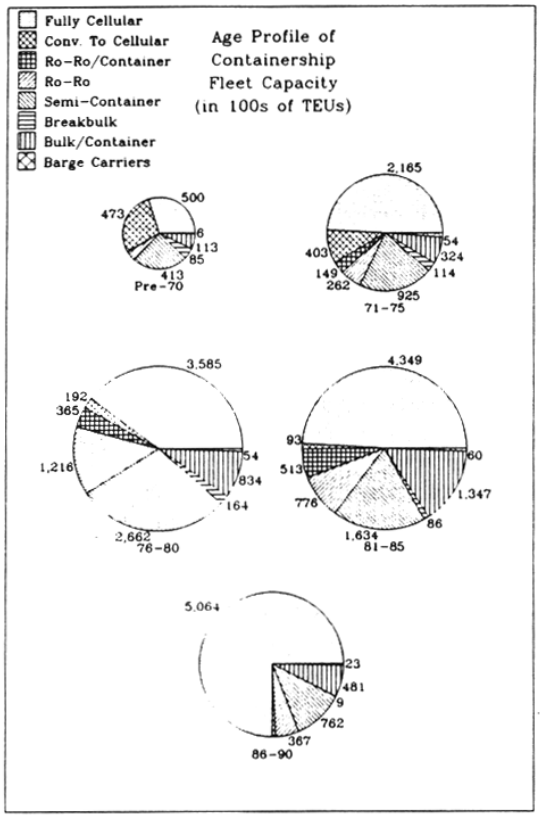

Screen Manager
MAPMAKER: Pane edit (Pane 1 - Pie chart)
Approve or change the options below and press PF12 to draw
Network name
GENSTAT or other data file
Type of geography in data file GRAPH
Label values AUTO
Label pies AUTO
Totals in legend NO
Legend Text AUTO
Window AUTO
Flip or no AUTO
1-Help 2-Peek File 3-Quit 4-Window 5-Move Pies 6-Edit Label
7-Aggr Pies 8-Make Table 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

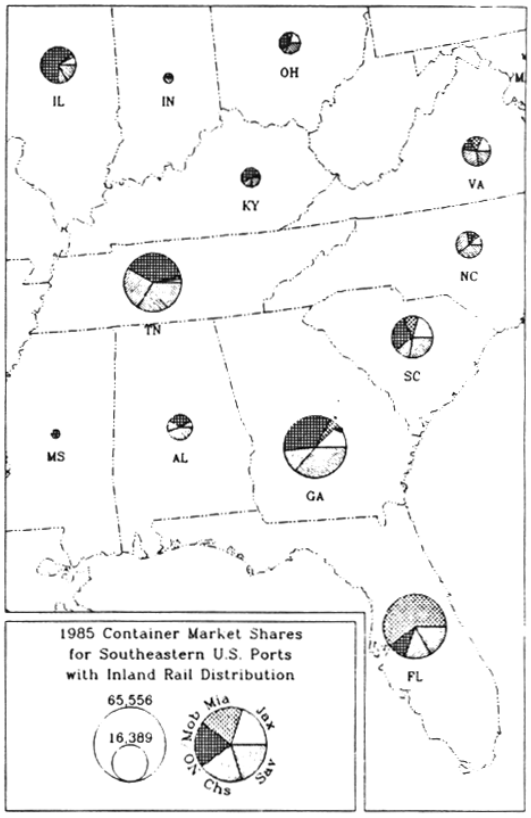
The PIE map edit menu

Introduction to pie charts

Pie charts, like bar charts, are used to graph one or more dependent variables against an independent variable. Both pie and bar charts graph discrete independent values. The decision to graph data with pies versus bars depends on what you think it is important to show about your data. A pie chart depicts quantities as area proportional pies with segments of the pies representing shares of the quantity. Area proportional pies make it easy to compare the total of the shares between the independent values. Bars are height proportional and make it easier to compare values in adjacent bars. Also, you can use bar shares to show the relationship between shares and the total bar value. You can label the total bar value. Pie charts do not let you label the total pie value, but instead you can label values of individual shares.

Pie charts, like bar charts, may be geographic or non-geographic. The types of geography supported are the same as those described for geographic bar charts. Refer to this manual's section called "Geographic bar charts" for further information. In the example below, the image on the left shows a non-geographic pie chart and the one on the right shows a geographic pie chart:





An example of a non-geographic pie chart *An example of a geographic pie chart*

Creating a basic pie chart

Creating a pie chart is similar to the procedure for creating a bar chart. A pie chart of input data can be created with the option defaults provided in the menu. The input data needed is the same as needed for a bar chart; a matrix with identifying information in the first column and quantities of information to be shown as pie shares in the remaining columns. For the pie chart to make sense, all quantities should be in the same unit of measure.

The PIE map edit menu looks almost identical to the BAR map edit menu. The options and the PF keys on the pie chart menu work exactly as they do on the bar chart menu. Refer to the section on creating bar charts for further information on the pie chart menu options and PF keys.

MAPSETUP options used in pie charts

As in the BAR map edit menu, **PF9** invokes the MAPSETUP options menu. You can use many of the MAPSETUP options described in this manual's section called "MAPSETUP options used in bar charts" to customize your pie chart.

You can also label pie values with percentage share in addition to or instead of actual values using the PCT option. PCT controls whether to label pie values with actual numbers (PCT=0), percentages (PCT=1) or both (PCT=2).

The RESOLUT option controls the resolution (number of points) of the pie circles. A value of 3 is recommended for page-size plots, but should be increased if you will be plotting the map in a large size. The MAX SIZE option is the radius, in screen coordinates, of the largest pie. Decrease MAX SIZE to make the pies smaller, and increase MAX SIZE to make them bigger.

Network mapping: NET and CARRIER panes

At the heart of the PTNM is its ability to work with network databases. The PTNM can be licensed with detailed and accurate representations of the North American rail, highway and waterway systems, and you can import your own network data or network data provided by third party logistics. Each network is defined in terms of nodes and links. Nodes represent locations such as cities, stations, or intersections. The nodes are connected together by links, which represent the highways, railroads, or waterways. Each node has an associated coordinate on an X-Y grid that allows maps of the networks to be drawn. The coordinate system on all three networks conforms to that of the PTNM's political boundary and other databases so that combined overlays can be drawn. Each link has associated with it various attributes such as distance and road quality.

Using networks with the PTNM

Networks are stored in disk files (with extension .ntw) so they can be used in different PTNM workspaces. You can load a network into the TRGRAPH workspace and use the TRGRAPH functions for accessing, editing, manipulating, and displaying network data.

The PTNM North American rail, highway, and waterway networks

The PTNM North American rail network contains approximately 43,000 nodes representing 70,000 freight stations, and approximately 44,000 links representing 250,000 route-miles of rail lines. All Class I and II, and nearly all Class III railroads in the U.S., Canada, and Mexico are represented.

Each node on the network is coded with one or more station names (city and state or province), Freight Station Accounting Codes (FSACs), Standard Point Location Codes (SPLCs), "3-3-3" Eastern Railroad Presidents' Conference (ERPC) format station names, and Rule 260 Junction Alpha Codes.
Every link on the PTNM rail network is coded with its actual railroad distance, taken from timetables or other official sources; the state or province the link is in; the AAR number and initials of the railroad company owning the link; the AAR number and initials or railroads having operating rights on the link; and a designation of track and route quality (high-density mainline, medium density mainline, medium density branch line, or low density branch line).

The PTNM highway network contains approximately 100,000 nodes, which are matched to 150,000 place names, and approximately 130,000 links which represent over 650,000 miles of highways in the U.S. and Canada. All interstate, federal, and primary state highways are included in the network, as well as some secondary and local highways.

Each node on the highway network is coded with one or more place names (city and state or province), and Standard Point Location Codes (SPLCs). U.S. Postal Service Zip Codes are contained in an auxiliary file for use with the network.

Every highway network link is coded with its actual highway distance, taken from official state and provincial highway maps; one or more highway route numbers; the state or province the link is in; type of road (limited access non-toll, limited access toll, open access divided, open access non-divided, and ferries); and type of vehicles permitted (all vehicles, or automobiles only). The highway network separately identifies automobile-only from truck-usable links.

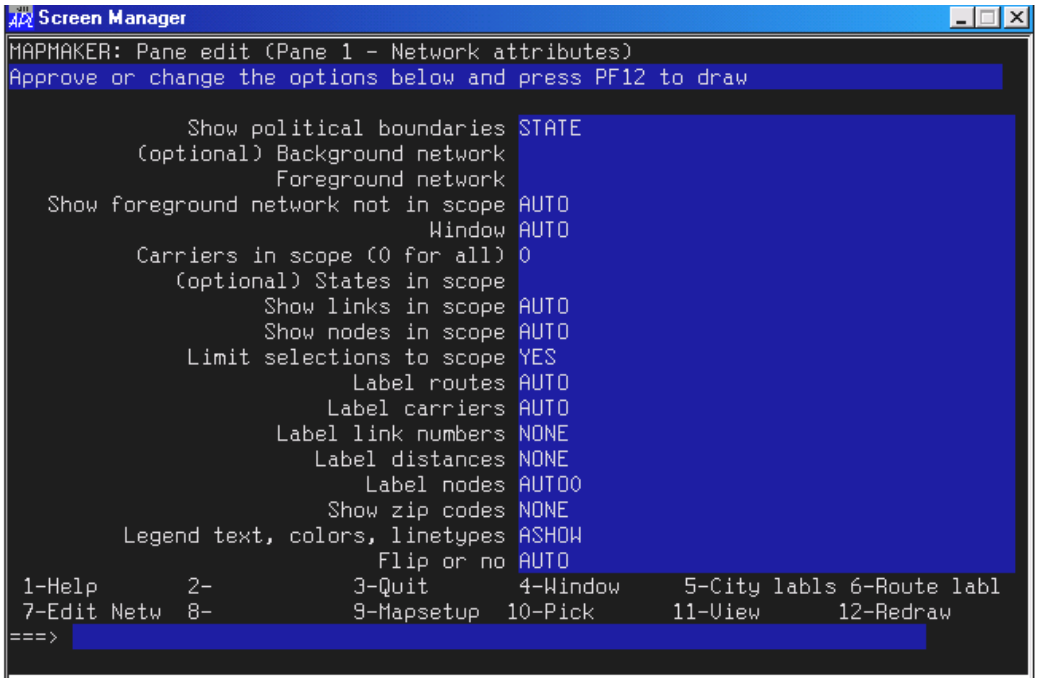
The PTNM waterway network contains approximately 10,000 nodes, which are matched to 52,000 port and dock locations, and approximately 10,000 links, which represent 400,000 miles of inland and coastal waterways, as well as major ocean and Great Lakes shipping routes, in the U.S. and Canada. Each node is coded with one or more of the U.S. Corps. of Engineers' port and dock codes. Nodes along the inland and gulf intra-coastal waterways have a waterway and mile designation as well. Each link of the network is assigned a distance and channel depth.

Importing non-PTNM networks into the PTNM

The networks described above are the ones continuously supported and maintained by ALK. A variety of other networks are used with the PTNM software. These include a world-wide shipping network; Chinese railroads; New York City streets; New Jersey bus routes; train schedule and blocking networks; airline schedule networks; and U. S. Census' Topological (TIGER) files. Use TRGRAPH command language to import non-PTNM networks.

NET - network attributes

The NET map edit menu lets you draw maps of network attributes, such as road type or route numbers. From the screen definition menu, press **PF10** or type the word **NET** to select the map edit menu for network mapping. After you select the pane, press **PF8** to edit the menu. The NET map edit menu looks like this:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Network attributes)
Approve or change the options below and press PF12 to draw
Show political boundaries STATE
(optional) Background network
Foreground network
Show foreground network not in scope AUTO
Window AUTO
Carriers in scope (0 for all) 0
(optional) States in scope
Show links in scope AUTO
Show nodes in scope AUTO
Limit selections to scope YES
Label routes AUTO
Label carriers AUTO
Label link numbers NONE
Label distances NONE
Label nodes AUTOO
Show zip codes NONE
Legend text, colors, linetypes ASHOW
Flip or no AUTO
1-Help 2- 3-Quit 4-Window 5-City labls 6-Route labl
7-Edit Netw 8- 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The NET map edit menu

Introduction to network mapping

Network mapping is used to draw maps showing network attributes. You can overlay a sketch of an optional *background* network while you look at attributes of the *foreground* network.

By default, the amount of attribute detail shown will increase the more you *zoom* in. You can fix the level of detail independent of the window by changing the default options.

Creating a basic network map

Before creating a network map, you must choose a network. The default network is the network already loaded in the workspace. If a network is not loaded in the workspace or you would like to change the default, move the cursor to the menu line *Foreground network* and either type over the default, or use **PF10** to select a network from the list of networks available to you.

Within the foreground network, you can highlight certain carrier(s) or state(s) you define as the *scope*. The default is to include all carrier(s) and state(s) as part of the

scope. For example, if you select carrier Burlington Northern Santa Fe and the state Illinois for your scope only BNSF links in the state of Illinois would be displayed on your map.

Move the cursor to the menu line *Carriers in scope (0 for all),* and type over the default with the carriers you want. Carriers are entered in this menu using standard TRGRAPH nomenclature, which is as follows.

TRGRAPH nomenclature	what it means
0	All carriers in the network
250 777 802	Carriers whose numbers are 250, 777 or 802
'WC BNSF UP'	Carriers whose initials are “WC”, “BNSF” or “UP”
FAM 'WC'	Family of the carrier whose initials are “WC”
FAM 250 400	Family of the carriers whose numbers are 250 or 400
ALLBUT FAM 'KCS'	All carriers EXCEPT the family of “KCS”
ALLBUT 400	All carriers EXCEPT the one whose number is 400

You can further limit your scope to certain states/provinces. The default is to show all states. Move the cursor to the *States in scope* menu line and type the state/province abbreviations (in quotes; for example, 'FL' for Florida) for the selected states.

You can also show the portion of the foreground network that is not in the scope, in a different color/line-type, by changing the *Show foreground network not in scope* to YES. You can underlay an optional background network (for example, show a rail network under a highway network) by typing the name of the network to the right of the *Background network* menu line or by pressing **PF10** to choose from those available.

After you choose the network and scope, press **PF12** to draw a network map using the rest of the supplied defaults, or to redraw after changing any of the defaults. To change a default, type over it, or use **PF10** to pick from permitted values.

Zooming in to see more detail

After the network map is drawn for the first time, you can change the geographic area shown (the window) to show more detail. Move the cursor to the *Window* option and type in the word MANUAL. Then press **PF4** to select from the menu of window

options. The first choice on this menu is ZOOM, which lets you use the graphic cursor to define a portion of the current window to be enlarged as the new window.

Link attributes and how to show them

Carriers

You can label each link with the carrier abbreviations of those carriers operating on the link using the menu option *Label carriers*. Choosing ALL will label the links with carriers (if you are not zoomed in far enough to discern individual links, the labels will overlap and may be unreadable). Choosing AUTO will determine whether or not to label all links automatically based on the kind of network and the window selected. The links will not be labeled with carriers, regardless of the window, if you choose the NONE option.

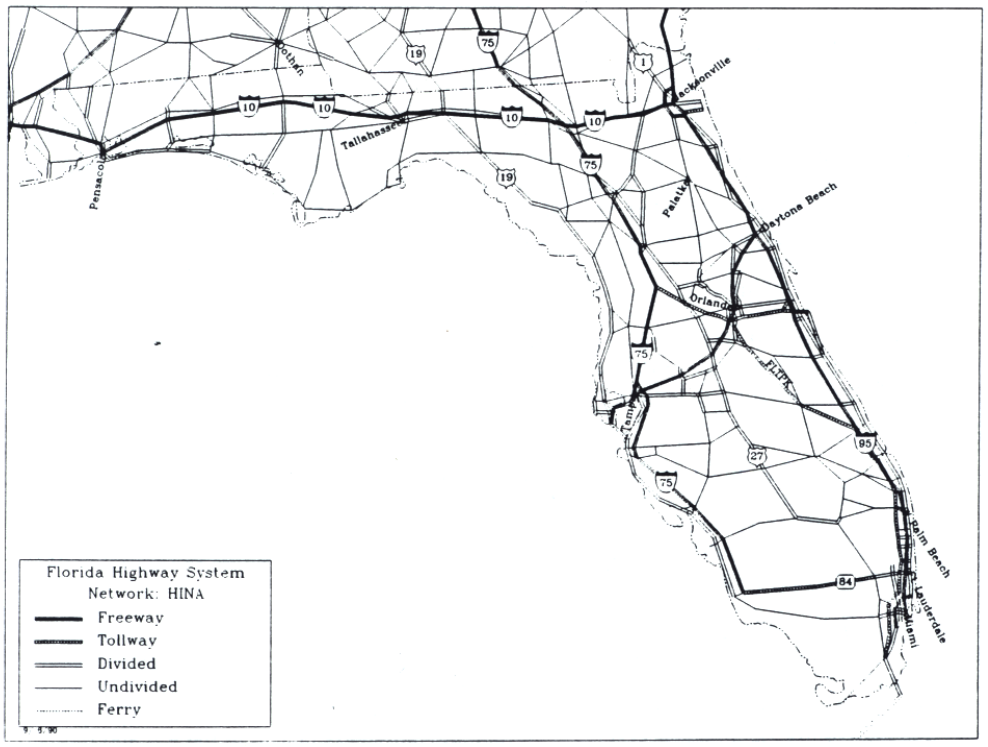
Distance

You can label each link with its actual distance using the *Label distances* option. Choosing ALL will label all links with distances (if you are not zoomed in far enough to discern individual links, the labels will overlap and may be unreadable). The links will not be labeled with distances if you choose the NONE option.

MLC code

You can show links by their designated MLC type codes using the *Show links in scope* option. The symbology used is to show each MLC type code with a different line-type and /or color. For the PTNM highway network, the MLC codes correspond to road quality: free limited access, toll limited access, divided, non-divided, and ferries. For the PTNM rail network, the MLC codes correspond to track type: high density mainline, medium density mainline, medium density branchline, and low density branchline. For the PTNM waterway network, the MLC codes correspond to channel depth. Choosing MLC will show all links in the scope by their MLC codes. Choosing AUTO will show all links by their MLC codes automatically based on the kind of network (i.e. for highway networks only). Choosing YES will show all links in scope without showing MLC codes.

The map legend will show the correspondence between MLC code and line color/line-type. The following figure shows an example of a NET map by MLC code:



Example of a map created with the NET pane menu

Route numbers

For the highway networks, you can label each link with route numbers using the *Label routes* option. The AUTO choice will automatically choose links to label based on the network kind and the window selected. No routes are labeled if you choose NONE.

After the map is drawn for the first time, you can select certain links to label using the GETLINKS menu. The GETLINKS menu lets you interactively choose links using the graphic cursor. Move the cursor to the *Label routes* option and type in the word MANUAL. Then press **PF6** to invoke GETLINKS. Links are selected by pressing the space bar between the two endpoints of a link. Your choice will be limited to the current scope if the option *Limit selections to scope* is YES.

Link numbers

You can label each link with its link number using the *Label link numbers* option. Choosing ALL will label all the links with link numbers (if you are not zoomed in far enough to discern individual links, the labels will overlap and may be unreadable). The links will not be labeled with link numbers if you choose the NONE option.

Node attributes and how to show them

You can label each node with the PTNM node number or city name it represents using the *Label nodes* option. The AUTO choice will automatically determine whether or not to label nodes based on the window selected. The BOTH option will label each node with its name and number. Choosing NUMS will label all nodes with their node numbers. Choosing NAMES will label all nodes with their city names. The NONE option will suppress labeling. If you are not zoomed in enough to discern individual links, the node labels placed with the NAMES, NUMS, or BOTH options will overlap and may be unreadable.

The city name labels are drawn at an angle such that they avoid overlapping each other, running off the edges of maps, or overwriting any links to be drawn on the map. You can force city names to be labeled horizontally by using the choices AUTO0, SOME0 and MANUAL.

After the map is drawn for the first time, you can select certain nodes to label using the IDENTIFY menu. The IDENTIFY menu lets you interactively choose nodes using the graphic cursor. Move the cursor to the *Label nodes* option and type in the word MANUAL. Then press **PF5** to invoke IDENTIFY. Your choice will be limited to the current scope if the option *Limit selections to scope* is YES.

For the PTNM rail network, each of the station names at a node is associated with a unique Freight Station Accounting Code (FSAC) assigned by the Association of American Railroads (AAR). For most nodes, there will also be one or more Standard Point Location Codes (SPLCs), a geographic coding system designed by the National Motor Freight Traffic and matched to the FSACs by the AAR.

SPLCs are 6 digit codes which correspond to individual place names in the U.S. and Canada. They are assigned in a hierarchical manner so that SPLCs which are close numerically correspond to places that are close geographically. The first digit of the SPLC designates a region of the U.S. (number 1-8) or Canada (number 0), or Mexico (number 9). The second digit indicates a state, province, or part of a state or province. The third digit identifies a county or group of adjacent counties: the fourth digit indicates a specific county or portion of that county. The fifth and sixth digits, indicate a specific place within that county or portion of that county. For example, the SPLC for Princeton, N.J. is 194537, and each digit indicates the following:

1 - region (Northeastern U.S.)
9 - state or portion (New Jersey)
4 - county or adjacent counties (Central New Jersey)
5 - county or portion (Mercer County)
3 - area within county or portion (N. Central Mercer County)
7 - specific place (Princeton, N.J.)

The FSAC numbers are 8-digit numbers indicating a specific rail freight station. The first 3 digits indicate the railroad, according to the AAR's numbering system, and the last 5 digits indicate the station on that railroad. As the station numbers are assigned

by the railroads themselves, the numbering system varies widely and cannot be counted on to follow any pattern. However, many railroad numbering systems do follow a pattern of some sort, such as stations in order on a certain line having adjacent FSAC numbers in the same order. For the PTNM highway network, only SPLCs (no FSACs) are available. For the PTNM waterway network, the U.S. Corps of Engineers' Port and Dock Codes are given instead of SPLCs or FSACs.

Showing zip code locations

You can show zip code locations, zip code numbers, and post office names using the *Show zip codes* option. Choosing LOC shows all zip code locations using small squares. Choosing NUMS shows all zip code locations with their zip code numbers. Choosing NAMES shows all locations with their post office names. The BOTH choice shows all zip code locations, numbers, and post office names. Zip codes are not shown if you choose the NONE option, which is the default. If you are displaying a network outside of North America, *Show zip codes* is not supported.

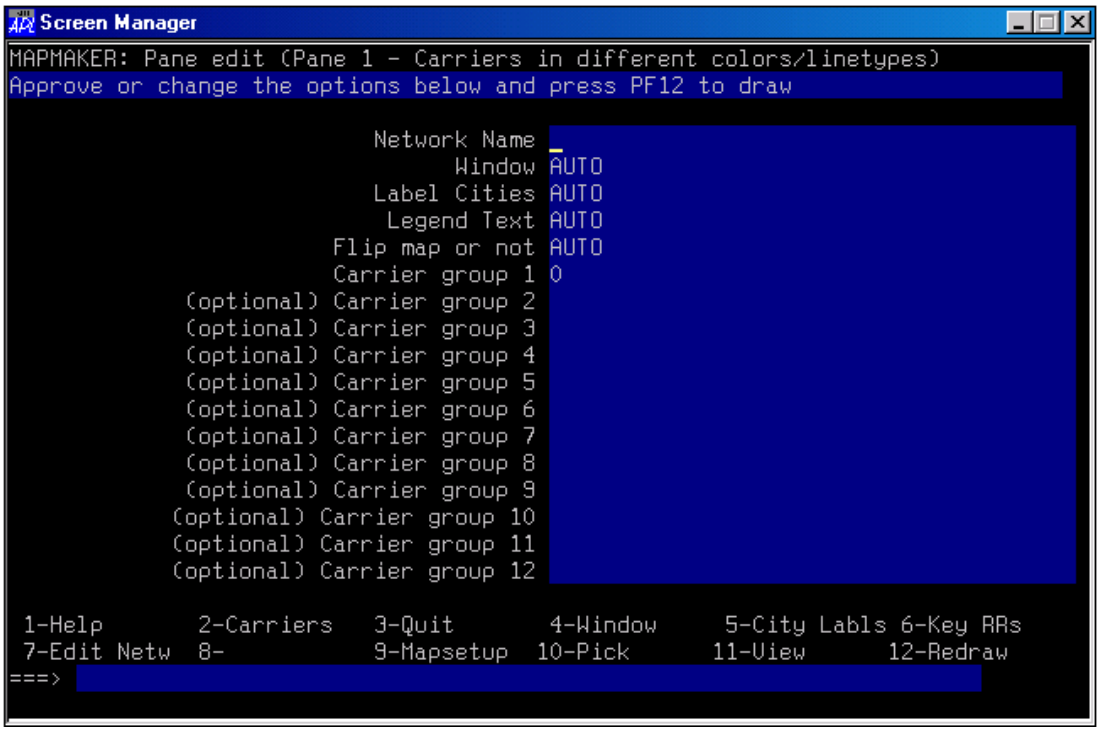
Showing a legend & altering symbology

In the NET map edit menu, the default is to show a legend. Changing the *Legend text, colors, line-types* option to AUTO suppresses the drawing of a legend but chooses the colors and line-types to use in the map automatically. You can change the colors and line-types chosen by changing the *Legend text, colors, line-types* option to MANUAL, and then pressing PF9 to invoke the MAPSETUP menu. The *Legend text, colors, line-types* option on the NET map edit menu is a bit different from other panes in that options chosen on the pane menu control which identifications are shown in the legend Move the cursor underneath the COLOR option to change the color of each identifier. Move the cursor underneath the LTYP option to change the line-type pattern of each identifier.

Choosing ASHOW for the *Legend text, colors, line-types* option will show the legend using default legend text, colors, and line-types. You can change the wording of the legend text and the colors and line-types by changing the option to MSHOW and then invoking the MAPSETUP menu. Move the cursor to the TEXT area to type in your legend text.

CARRIER - carriers in different colors/line-types

Using the CARRIER map edit menu, you can draw a map of an entire network or part of a network, and draw each carrier in a different color or line-type. From the screen definition menu, press **PF10** or type the word **CARRIER** to select the map edit menu for a carrier map. After you select the pane, press **PF8** to edit the menu. The CARRIER map edit menu looks like this:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Carriers in different colors/linetypes)
Approve or change the options below and press PF12 to draw
Network Name
Window AUTO
Label Cities AUTO
Legend Text AUTO
Flip map or not AUTO
Carrier group 1 0
(optional) Carrier group 2
(optional) Carrier group 3
(optional) Carrier group 4
(optional) Carrier group 5
(optional) Carrier group 6
(optional) Carrier group 7
(optional) Carrier group 8
(optional) Carrier group 9
(optional) Carrier group 10
(optional) Carrier group 11
(optional) Carrier group 12
1-Help 2-Carriers 3-Quit 4-Window 5-City Labls 6-Key RRs
7-Edit Netw 8- 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The CARRIER map edit menu

An example of a carrier map was given near the start of this chapter under the heading "General features of map edit menus".

Creating a basic carrier map

As in the NET map edit menu, you must choose a network before creating a carrier map. The default network is whatever network is already loaded in the workspace. If a network is not loaded in the workspace or you would like to change the default, move the cursor to the menu line *Network Name* and either type over the default, or use PF10 to select a network.

You must enter a carrier or carriers for the option *Carrier Group 1*. You can see what carriers are in the network by pressing **PF2**. The default is 0 which selects all carriers. Carriers are entered in this menu using the standard TRGRAPH nomenclature described earlier in this manual, under the heading "Creating a basic network map" of the NET map menu.

If you want to see different carriers in different colors or line-types, enter carriers under optional groups 2 through 12. You can press **PF6** and MapMaker will automatically fill in groups 1 through 12 with the largest carriers in your network.

After you choose the network and carriers, press **PF12** to draw a carrier map using the rest of the supplied defaults, or to redraw the map after changing any of the defaults.

Choosing nodes to label

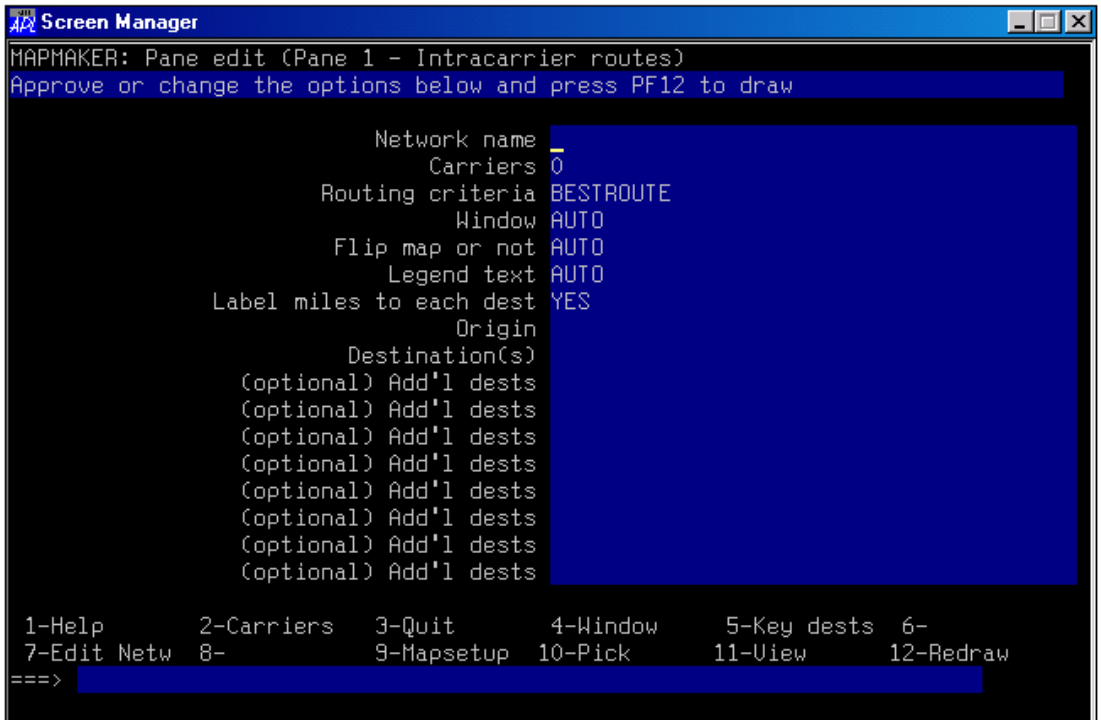
After the carrier map is drawn the first time, you can change which nodes to label using IDENTIFY. First, move the cursor to the *Label Cities* option and type in the word MANUAL. Then press **PF5** to invoke the IDENTIFY menu. Refer to the NET map edit menu section "Node attributes and how to show them" for more details on how to use IDENTIFY.

MAPSETUP options used in carrier mapping

The color and line type for each carrier group can be changed from the default values by pressing **PF9** to invoke MAPSETUP. The IDENTIFICATION area at the lower left of the menu controls how each carrier group is labeled in the legend. Adjacent to the text identifying each carrier group, you can control the color and line type pattern for each carrier. The options can be scrolled using **PF7** (up) of **PF8** (down). Refer to this manual's section called "MAPSETUP options used in bar graphs" for information on other MAPSETUP options.

ROUTE - route maps

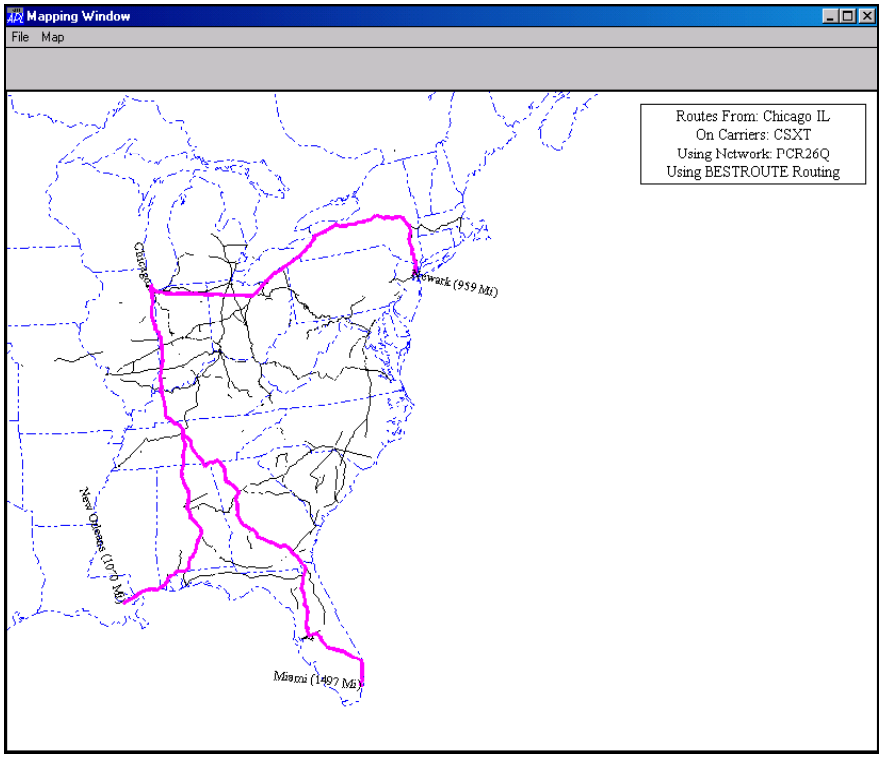
With the ROUTE map edit menu, you can draw a map of routes within a carrier or group of carriers from an origin to one or more destinations. From the screen definition menu, press **PF10** or type the word **ROUTE** to select the map edit menu for a route map. Press **PF8** to edit the menu. The ROUTE map edit menu looks like this:



The ROUTE map edit menu

Introduction to route maps

Route maps are used to show intra-carrier routes within a single transportation mode. Route maps can show a single route, routes from one origin to multiple destinations, or routes from multiple origins to multiple destinations. The example below shows a route map with one origin and multiple destinations:



An example of a map created with the ROUTE map menu

How routes are computed

The PTNM includes a minimum impedance routing program for computing routes. Each link in the network has an associated impedance, based on distance, travel time, dollar cost, accident probability, population exposure, or other link attributes either singly or in combination. The minimum impedance route between any two nodes on the network is the sequence of connecting links whose impedance sum is less than any other sequence of links.

Each of the three modal networks supplied with the PTNM (highway, rail, and waterway) has a calibrated impedance formula called *BESTROUTE* which replicates most likely service routes On the highway network, the formula is a combination of distance and road type (free limited access, toll limited access, divided, non-divided, and ferries). On the rail network, the formula is a combination of distance and route quality (high-density mainline, medium density mainline, medium density branch

line, and low-density branch line). On the waterway network, the formula is minimum distance.

Creating a basic route map

For the ROUTE map edit menu, you must choose a network, one or more carriers, an origin, and at least one destination. Move the cursor to the menu line *Network name* and either type over the default, or use **PF10** to select a network. Carriers are entered in this menu using the standard TRGRAPH nomenclature described above in this manual on network mapping. You can see what carriers are in the network by pressing **PF2**.

Origins and destinations may be specified such as

location	what it means
'CHICAGO IL'	Chicago, Illinois
16434	The node whose number is 16434
SPLC2NODE 380000	The node corresponding to SPLC 380000
FSAC2NODE 02200001	The node corresponding to FSAC 02200001
'CHICAGO IL, ST LOUIS MO'	Chicago, Illinois and St. Louis Missouri
16434 13599	The nodes whose numbers are 16434 or 13599

Move the cursor to the menu line *Origin* and type in an origin location. Move the cursor to the menu line *Destination* and type in a destination location. You can press **PF5** to automatically generate a list of major destinations after you have selected a network and carrier(s).

Press **PF12** to draw a route map using the rest of the supplied defaults, or to redraw the map after changing any of the defaults.

Adjusting routing criteria

In the ROUTE map edit menu, you can select the routing criteria MapMaker will use to compute the routes. The default routing criteria is BESTROUTE. Move the cursor to the menu line *Routing criteria* and type over the default or press **PF10** to select a criteria from the list of choices. The two other choices are DIST and SHORTROUTE. The DIST formula is pure minimum distance routing, using the values in the network variable DIST. The SHORTROUTE formula is the same as DIST for the rail and waterway networks; for the highway network, it is the minimum distance formula with someconsideration of road quality, but not as much as BESTROUTE.

Labeling miles

The distance to each destination is labeled on the map using the option *Label miles to each dest.* If you choose the default YES, the mileage will be labeled next to each destination. The mileages will not labeled if you choose NO.

Multiple origins

You can generate routes from multiple origins by specifying more than one origin in the menu. On the menu line *Origin*, type in each origin city and state name separated by a comma. For example, if you type in:

'ST LOUIS MO, CHICAGO IL'

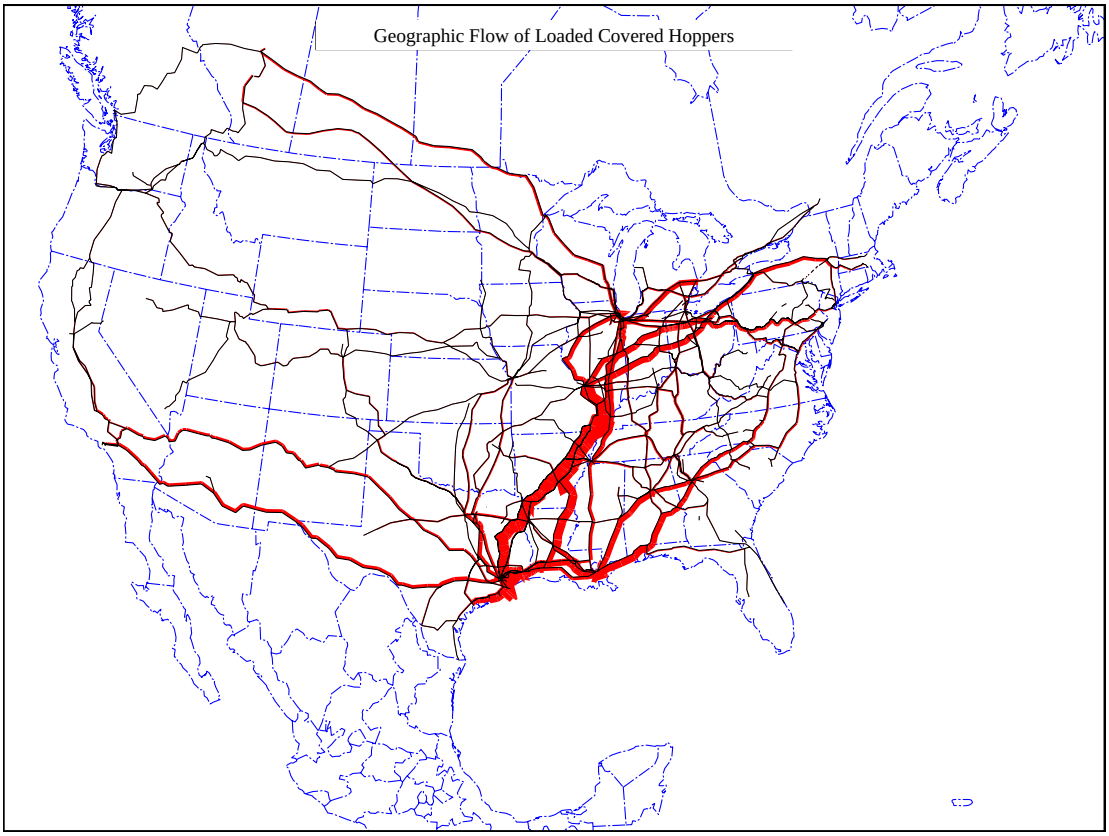
as origins, MapMaker compares the routes from both St. Louis, MO and Chicago, IL to each of the destinations, and displays the minimum impedance route based on the routing criteria to each destination. Each destination will be connected to the origin that is "closest" based on the routing criteria that you specify.

Traffic density charts

Introduction to traffic density mapping

Given a database containing the amount of traffic between various origins and destinations, the PTNM's ALKFLOW traffic assignment program can compute the volume of that traffic on each link of a network. The program efficiently computes the route for each traffic record and sums up the amount of traffic routed over each link. The result of the traffic assignment can then be listed in a table or displayed graphically as a traffic density chart.

For example, the following map graphs, on an aggregated rail network, the density of covered hopper cars from the 2001 Surface Transportation Board Public Use Waybill Sample.



Traffic density chart of covered hopper cars on an aggregated rail network

In a traffic density chart, the amount of traffic on each network link is shown as a bandwidth around the link, where the width of the band is proportional to the amount of traffic. The relative proportion of traffic by direction is indicated by how much of the bandwidth is on one side of the link or the other. By convention, the PTNM uses a “right-hand rule” to indicate direction. As one looks along a link, the forward moving volume is drawn on the right-hand side of the link.

A traffic density chart can show: a single traffic flow, a single traffic flow with the maximum (headhaul) and minimum (backhaul) volumes on a link in different colors or line-types, multiple traffic flows, or changes in flow (gains and losses).

Format of input data

The link volume matrices used by MapMaker have link numbers in the first column followed by one or more two-column groups of link volumes called *flow groups*. An example of a flow record looks like this:

1031 40 0 1900 0

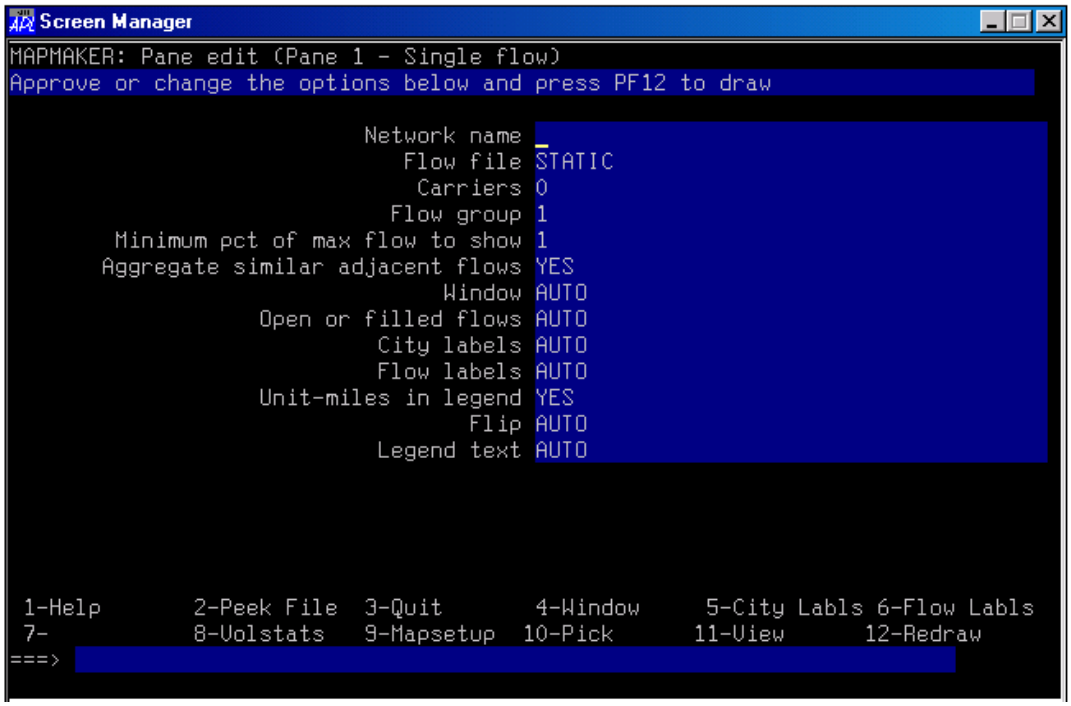
This record is a result of flowing a set of traffic volume data with two volumes associated with each record. The numbers represent the following:

1031	link number
40	volume 1 in forward direction on link 1031
0	volume 1 in backward direction on link 1031
1900	volume 2 in forward direction on link 1031
0	volume 2 in backward direction on link 1031

Refer to *ALKFLOW, and OPTFLOW User Documentation*, for more information on creating a flow file from origin-destination data.

FLOW - simple traffic density chart

With the FLOW map edit menu, you can draw a traffic density map of a single traffic flow. From the screen definition menu, press **PF10** or type the word **FLOW** to select the map edit menu for a traffic density chart. After you select the pane, press **PF8** to edit the menu. The FLOW map edit menu looks like this.


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Single flow)
Approve or change the options below and press PF12 to draw
Network name
Flow file STATIC
Carriers 0
Flow group 1
Minimum pct of max flow to show 1
Aggregate similar adjacent flows YES
Window AUTO
Open or filled flows AUTO
City labels AUTO
Flow labels AUTO
Unit-miles in legend YES
Flip AUTO
Legend text AUTO
1-Help 2-Peek File 3-Quit 4-Window 5-City Labls 6-Flow Labls
7- 8-Volstats 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The FLOW map edit menu

Creating a traffic density chart

Before creating a traffic density chart, you must enter in the menu the name of the network that was used to flow your input flow file. The default network is the network loaded in the workspace. If a network is not loaded in the workspace or you would like to change the default, move the cursor to the menu line *Network Name* and either type over the default, or use **PF10** to select a network.

Enter the name of your input flow file on the menu line *Flow file*. The default flow file is the most recent one on your disk. To pick another file from those on your disk, place the cursor on the menu line for *Flow file* and press **PF10**. You can see the number of flow groups in the flow file and what carriers are in the network by pressing **PF2**. The default flow group number is 1. The default for the *Carriers* option is 0 which selects the volumes for all carriers to be shown. Carriers are entered in this menu using the standard TRGRAPH nomenclature described earlier in this manual under the heading “Network mapping”.

After you choose the network and flow file, press **PF12** to draw a traffic flow map of the chosen flow group using the rest of the supplied defaults, or to redraw the map after changing any of the defaults.

After the first drawing of the map, you can use **PF8** to see unit-mile statistics on all the flow groups for the carrier(s) you have selected.

Choosing nodes to label

After the traffic density map is drawn for the first time, you can choose which nodes to label using IDENTIFY. The IDENTIFY menu lets you interactively choose nodes using the graphic cursor. First, move the cursor to the *City labels* option and type in the word MANUAL. Then press **PF5** to invoke the IDENTIFY menu. Refer to the NET map edit menu section "Node attributes and how to show them" for more details on how to use IDENTIFY.

Choosing links to label

After the traffic density map is drawn for the first time, you can choose which flows to label using GETLINKS. The GETLINKS menu lets you interactively choose links using the graphic cursor. To invoke GETLINKS, move the cursor to the *Flow labels* option and type in the word MANUAL. Then press **PF6** to invoke the GETLINKS menu. Refer to the NET map edit menu section "Link attributes and how to show them" for more details on how to use GETLINKS.

Other options on the flow map menu

When graphing very large volume matrices, the number of links with volumes is so large that the result produced can be illegible due to links and volumes overwriting one another. You can aggregate adjacent links with near-identical volumes and/or eliminate those links with volumes less than a certain percent of the maximum to make the map more readable. The number of unique volume boxes or bands drawn can be reduced by aggregating links. You can choose to aggregate adjacent links by changing the default to YES for the option *Aggregate similar adjacent flows*. The *Minimum pct of max flow to show* option, can be used to eliminate volumes less than a percentage of the maximum volume. For example, if you leave the default minimum percent at 1 and the maximum flow in your input file is 4800 units, then any flow less than 48 units will not be shown.

Choose FILLED for the option *Open or filled flows* to fill in the flow boxes with fill colors or patterns. If you choose OPEN, the flows will be drawn as outline boxes. The AUTO choice will determine whether or not to fill the flow boxes based on the workstation type you are using.

Choose YES for the option *Unit-miles in legend* to calculate the number of unit-miles and display the total in the legend.

MAPSETUP options used in flow mapping

Press **PF9** to invoke the MAPSETUP options menu. To change the color in which the flow is drawn, move your cursor next to the FCOLOR option and type over the default with a different color. You can also change the fill pattern for filled flows using the FILL PATT option. Move your cursor next to the FILL PATT option and type over the default with a different fill pattern. The fill pattern values range from 1 to 15.

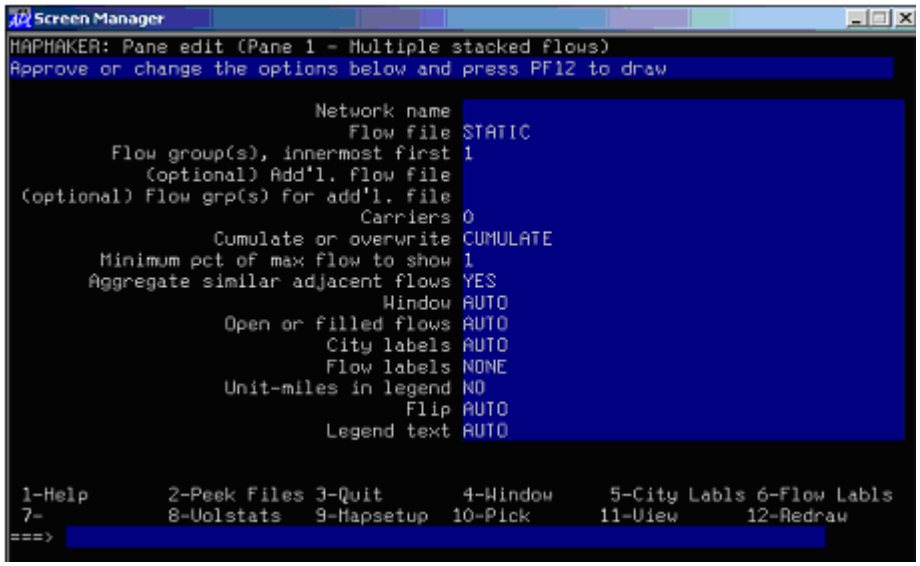
You can highlight the directionality of a flow by drawing the maximum and minimum flows on a link in different colors. You can do this by specifying two different colors for the FCOLOR option, separated by a slash (/). For example, if you type in GREEN/RED for the FCOLOR option, the maximum volume on each link will be filled in green and the minimum volume on each link will be filled in red. On monochrome workstations and printers, different shades of gray will correspond to each color designation.

The flows in MapMaker are drawn with either automatic or manual scaling. With the AUTOSCALE option as 1, MapMaker will automatically scale the width of the largest flow volume. If you set the AUTOSCALE option to 0, scaling will be determined according to the value in the MAXVOL parameter. By adjusting the MAXVOL parameter, the width of the largest box on the map can be increased or decreased as desired. For example, if you have set up a multiple-pane screen and wish to draw flows at a common scale in all panes, set the AUTOSCALE option to 0 for manual scaling after drawing the first pane. The flows in the rest of the panes will be drawn with respect to the maximum volume of the flow in the first pane.

Three MAPSETUP parameters, DOLLAR, CUTLAB, and OUTLAB can be used to control flow labeling. The DOLLAR option lets you control whether or not to place a dollar sign ($) before the flow values on the map and in the legend. Set this option to 1 if you want the dollar sign drawn. If you set the CUTLAB option to 1, labels will be suppressed on links which are too short for the label to fit. If the OUTLAB option is 1, labeling of flows will be forced outside of flow boxes; if the OUTLAB option is 0, labeling will be made inside the flow boxes if it can fit there.

FLOWMULT - multiple traffic densities on one chart

With the FLOWMULT map edit menu, you can draw a traffic density map of multiple traffic flows, stacked either on top of or adjacent to each other on a link. For example, you can show: loaded and empty equipment flows on one map, flow of a commodity as a portion of total flow, or flow of several equipment types on one map. Use a multiple flow map whenever you want to see the individual components of a total flow as well as the total on one map. From the screen definition menu, press **PF10** or type the word **FLOWMULT** to select the map edit menu for a traffic density chart of multiple flows. After you select the pane, press **PF8** to edit the menu. The FLOWMULT map edit menu looks like this:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Multiple stacked flows)
Approve or change the options below and press PF12 to draw
Network name
Flow file STATIC
Flow group(s), innermost first 1
(optional) Add'l. flow file
(optional) Flow grp(s) for add'l. file
Carriers 0
Cumulate or overwrite CUMULATE
Minimum pct of max flow to show 1
Aggregate similar adjacent flows YES
Window AUTO
Open or filled flows AUTO
City labels AUTO
Flow labels NONE
Unit-miles in legend NO
Flip AUTO
Legend text AUTO
1-Help 2-Peek Files 3-Quit 4-Window 5-City Labls 6-Flow Labls
7- 8-Volstats 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The FLOWMULT map edit menu

Creating a density chart showing more than one flow

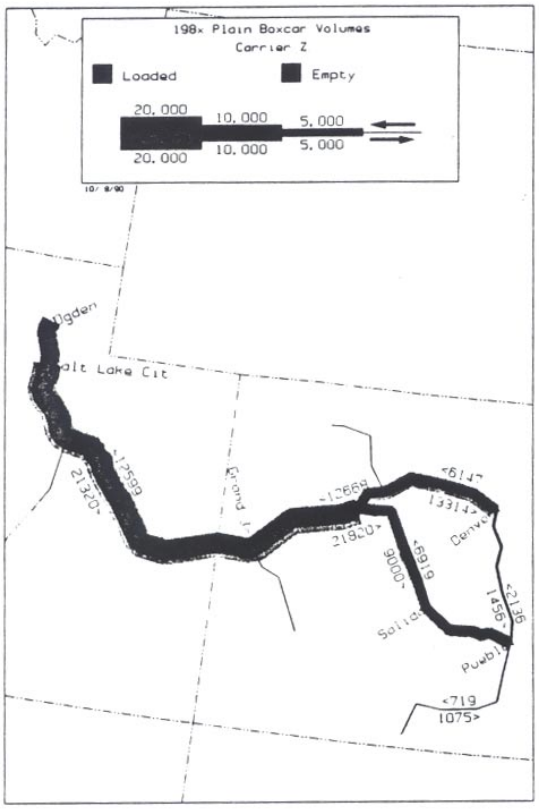
The FLOWMULT menu can show two or more flows from one or two flow files on the same map. Enter the name of the first flow file on the menu line *Flow file* and the flow group number on the menu line *Flow groups(s), innermost first*. To show other flows from the same flow file, enter each additional flow group number next to the number selected as the innermost flow group. These flows will be drawn consecutively after the first one. To show flows from a second flow file enter the name of the second flow file on the menu line *Add'l flow file* and enter each additional flow group number on the menu line *Flow grp(s) for add'l. file*. These flows will be drawn outermost. You are not limited in the number of flows you can show simultaneously with the FLOWMULT menu, but if you try to show too many flow groups on one map, the map will be cluttered and unreadable.

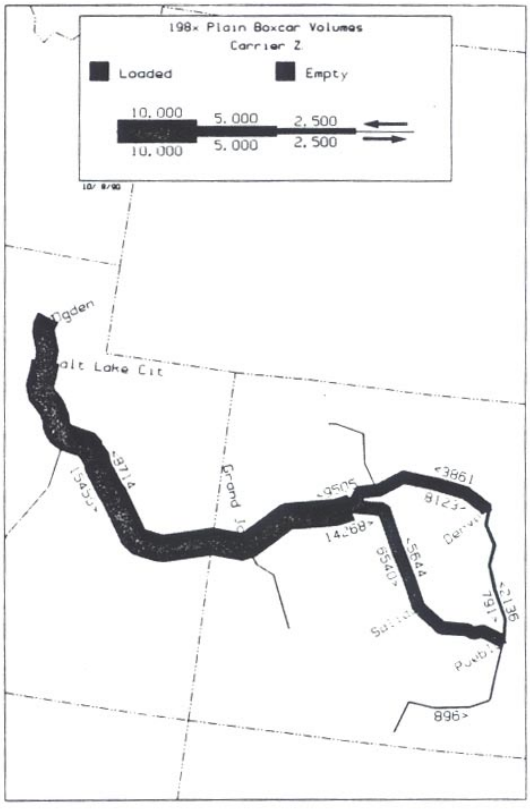
The order of stacking has a big effect on the appearance of a map. Changing the order of the flow groups may produce a map that better represents your data and better fulfills your purpose for showing it. After producing your first map, try changing the order of the flow groups to see whether that improves the appearance of the map.

Before creating a multiple flow map, you must enter the name of the network that was used in the traffic assignment program to flow both input files. The default network is the network loaded in the workspace. If a network is not loaded in the workspace or you would like to change the default, move the cursor to the menu line *Network Name* and either type over the default, or use **PF10** to select a network.

You can cumulate flows (display the second group outside the first), or overwrite flows (draw the first flow on top of the second). The default for the *Cumulate or Overwrite* option is cumulate. In the following example, the image on the right shows

loaded and empty flows of plain boxcar movements using cumulate and the one on the right shows the same flows using overwrite.

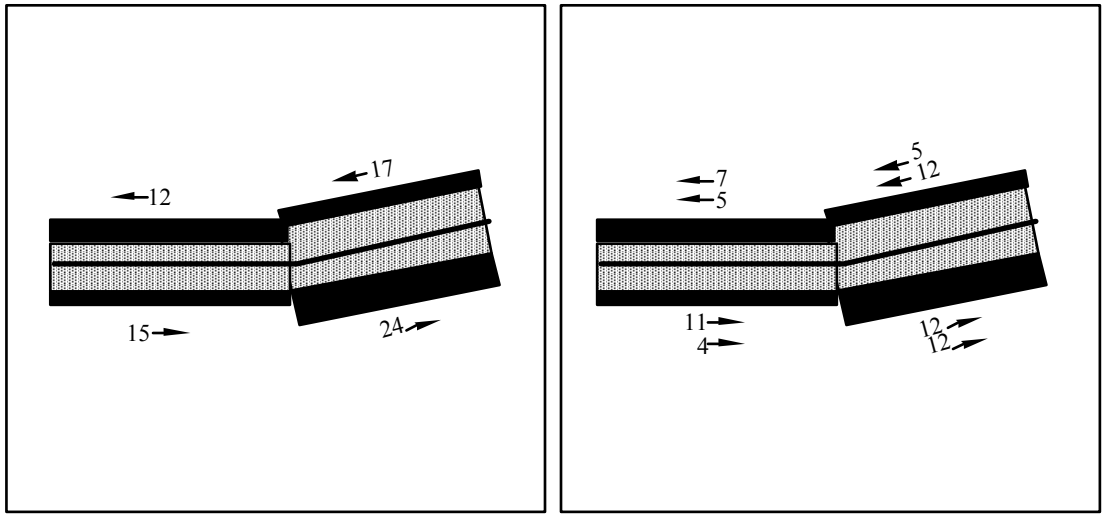




Multi-flow map using cumulate *Multi-flow map using overwrite*

With the *Flow labels* option set to AUTO, important <u>total</u> flows are labeled automatically on the map. To change which flows are labeled, change the *Flow labels* option to MANUAL and press **PF6**. This will invoke the GETLINKS menu that lets you interactively choose flows using the graphic cursor. To label all total flows on the map, change this option to ALL.

If you are creating a map with only two flow groups, the *Flow labels* option lets you label each of the flows individually. The AUTO2, MANUAL2, and ALL2 choices work the same as the AUTO, MANUAL, and ALL choices except that both flows on the links are labeled individually. In the example below, the flows on the left have a single label for the total flow and the flows on the right have two labels for the two individual components of the total flow.



One flow label *Two flow labels*

After you choose the network, input flow file(s) and flow groups, press **PF12** to draw a multiple flow traffic density chart. The other options in the FLOWMULT pane menu work the same as in the FLOW pane menu. To change a default, type over it, or use **PF10** to pick from permitted values. Press PF12 to redraw the map after changing any of the defaults.

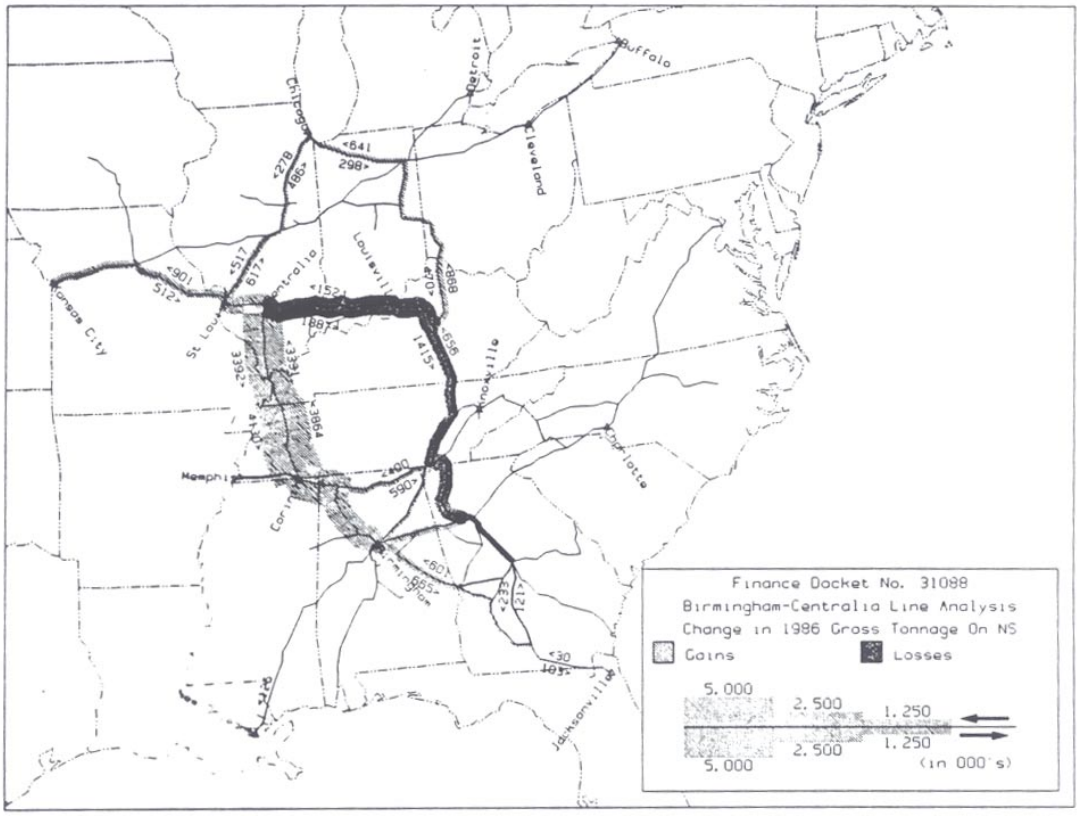
MAPSETUP options used in mapping multiple flows

Press **PF9** to invoke the MAPSETUP options menu. You can use the IDENTIFICATION field of MAPSETUP to identify the different flows on the map. You can change the text, color and fill pattern of each identifier. To enter text, move the cursor underneath the IDENTIFICATION area and type. The first line corresponds to the innermost flow, the second line corresponds to the next closest, etc. To change the colors of the flows, move the cursor underneath the COLOR option and type in different colors. To change the shade patterns of the flows, move the cursor underneath the PATRN option and type in different pattern numbers. For information on other MAPSETUP options you may want to use to customize your multiple flow traffic density chart, see this manual's section called “MAPSETUP options used in flow mapping”.

FLOWCHNG - change in traffic density

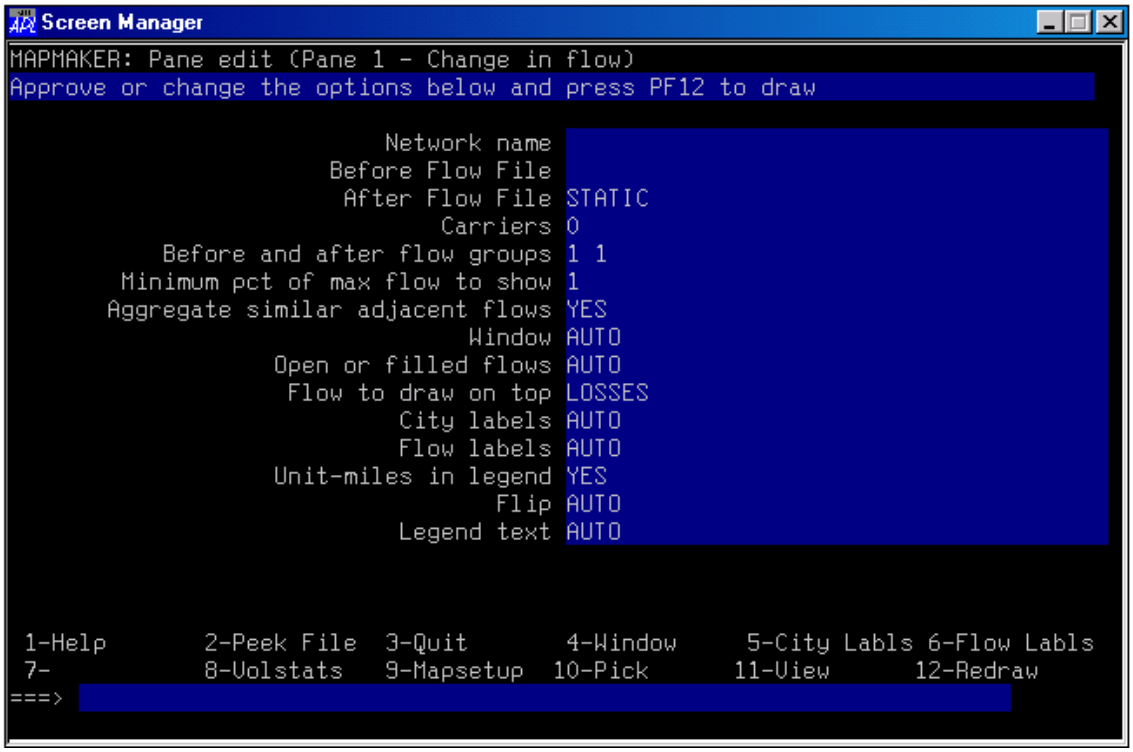
With the FLOWCHNG map edit menu, you can draw a traffic density map of changes in traffic flows (gains and losses). For example, suppose you were conducting a

"what if" study to determine the change in traffic flow if a new, more direct rail line was added to a carrier's system. In this example, a network is edited to code the carrier's new service. The carrier's traffic is flowed on both the base and edited networks using the traffic assignment program. The results can be compared in a traffic density map showing the changes in flow before and after the new service. The figure which follows is an example of a traffic density map produced using the FLOWCHNG pane menu. It shows the changes in traffic flow on the Norfolk Southern system due to the addition of a rail line from Centralia, Illinois to Corinth, Mississippi.



Traffic density chart showing changes in flow on the Norfolk Southern system

From the screen definition menu, press **PF10** or type the word **FLOWCHNG** to select the map edit menu for a traffic density chart of changes in traffic flows. After you select the pane, press **PF8** to edit the menu. The FLOWCHNG map edit menu looks like this:


Screen Manager
MAPMAKER: Pane edit (Pane 1 - Change in flow)
Approve or change the options below and press PF12 to draw
Network name
Before Flow File
After Flow File STATIC
Carriers 0
Before and after flow groups 1 1
Minimum pct of max flow to show 1
Aggregate similar adjacent flows YES
Window AUTO
Open or filled flows AUTO
Flow to draw on top LOSSES
City labels AUTO
Flow labels AUTO
Unit-miles in legend YES
Flip AUTO
Legend text AUTO
1-Help 2-Peek File 3-Quit 4-Window 5-City Labls 6-Flow Labls
7- 8-Volstats 9-Mapsetup 10-Pick 11-View 12-Redraw
===>

The FLOWCHNG map edit menu

Creating a map of changes in traffic density

The FLOWCHNG menu computes the difference between flow groups in the same or different flow files. Enter the name of the before flow file on the menu line *Before flow file* and the flow group number as the first entry on the menu line *Before and after flow groups*. Enter the name of the after flow file on the menu line *After flow file* and the flow group number as the second entry on the menu line *Before and after flow groups*. If both flow groups are in the same file, enter the same flow file name for both the before and after flow files.

The difference in flows will only make sense if the same unit of measure is used in both flow groups (i.e. trailers vs. trailers, or tons vs. tons).

Whether the gains or losses are drawn last (drawn on top) may affect the appearance of the map. Changing the order may produce a map that better represents your data. To control which flow is drawn on top, enter the word LOSSES or the word GAINS on the menu line *Flow to draw on top.*

After you choose the network, input flow file(s) and flow groups, press **PF12** to draw a map of changes in traffic density. The other options in the FLOWCHNG pane menu work the same as in the FLOW pane menu. To change a default, type over it, or use **PF10** to pick from permitted values. Press PF12 to redraw the map after changing any of the defaults.

MAPSETUP options used in mapping the change in flows

Press **PF9** to invoke the MAPSETUP options menu. You can use the IDENTIFICATION field of MAPSETUP to customize how the gains and losses are identified on the map. You can change the text, color and fill pattern of each. To enter text, move the cursor underneath the IDENTIFICATION area and type. The first line corresponds to the flow drawn first and the second line corresponds to the flow drawn last (on top). To change the colors of the flows, move the cursor underneath the COLOR option and type in different colors. To change the shade patterns of the flows, move the cursor underneath the PATRN option and type in different pattern numbers. If you press **PF1** (Help) with the cursor in one of these fields, additional help (such as color choices) will be given on the screen.

For information on other MAPSETUP options you may want to use to customize your traffic density chart of flow changes, see section in this manual under the heading "MAPSETUP options used in flow mapping".

Advanced use of the MAPSETUP options menu

Each MapMaker pane includes a default legend that you can customize using the MAPSETUP options menu. Specific MAPSETUP options which will customize legends for particular map types are described in the section for that map type. The section which follows describes ways to make more advanced use of the MAPSETUP options menu to customize any map legend.

Customizing the legend

You may want to add your initials to the map legend so that a person reading the map will know what person created it. Using the MAPSETUP options menu, you can add your initials under the legend border next to the date. Move the cursor next to the word INITIALS and type in your initials. Next time the map is drawn, your initials will appear on the map. If you prefer not to add your initials and to have the date removed, enter NO for the INITIALS option.

On some maps, there may not be any area of unused space large enough to draw the legend without drawing the legend on top of the political boundaries. This can cause a legibility problem. In this case, you can place the legend flush in a corner by setting the FLUSH option to YES. Next time the map is drawn, the political boundaries that would have been drawn in the legend area will be clipped off around the legend box.

You may also want to change what corner MapMaker has selected to place the legend. To do this, move the cursor to the CORNER option and type in the number that represents your desired choice: 0 for top center, 1 for lower left, 2 for lower right, 3 for upper right, 4 for upper left, and 5 lets you choose the location using the graphic cursor. If you type in 5, the graphic cursor will immediately appear for you to use in positioning the legend. Follow the menu instructions which apply to your workstation type.

You can control the width of the empty space between the legend and the border with the GUTTER option. If you increase the default value, you increase the width of the gutter. If you decrease the default value, you reduce the width of the gutter.

The size of labels drawn on a map are controlled with the LAB SIZE option. The size parameter is a fraction of the standard lettering size. You can specify the font to use for labels using the LAB FONT option.

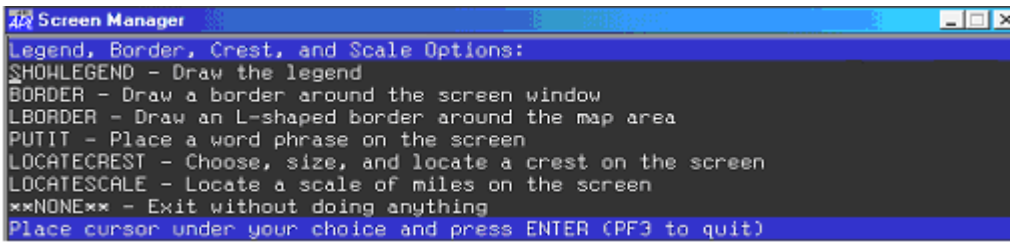
The particular fonts which are shown on your workstation or hard-copy device may be different than the requested font because of hardware limitations. You can always get a requested font by setting the value of the PLOT option to 1, but this may greatly increase the amount of time needed to redraw the map, since it will force each character to be drawn as a series of vectors.

The LINESPACE option controls the spacing for line-types and fill patterns on pen plotters. A value of 1 is adequate for normal size plots, but should be decreased to .25 for wall size maps. The PLOT option, if set to 1, generates all filling and characters using vectors. This will be automatically set to 1 when creating pen plots, otherwise this value should be 0.

The FEATURE option, which is at the top center in the MAPSETUP options menu, may be used to alter the set of fields displayed by MAPSETUP in order to accommodate different map types.

Previewing the legend within MAPSETUP

You can preview what changes you have made to the legend without leaving MAPSETUP and without redrawing the entire map. Press **PF9** within MAPSETUP to invoke a menu that looks like this.


Screen Manager
Legend, Border, Crest, and Scale Options:
SHOWLEGEND - Draw the legend
BORDER - Draw a border around the screen window
LBORDER - Draw an L-shaped border around the map area
PUTIT - Place a word phrase on the screen
LOCATECREST - Choose, size, and locate a crest on the screen
LOCATESCALE - Locate a scale of miles on the screen
NONE - Exit without doing anything
Place cursor under your choice and press ENTER (PF3 to quit)

Legend, border, crest, and scale options in MAPSETUP

Select *SHOWLEGEND* from this menu to draw your legend using the most current option settings. If you made an adjustment to the gutter size and wanted to check the result, you could select *BORDER* to draw a border around your map. Or, if your legend is flush in the corner, you could select *LBORDER* to draw an "L-shaped border" around your map.

Selecting *LOCATESCALE* lets you place a scale of miles (or kilometers) at any place on the pane. The size of the scale box can be controlled by changing the SCALE SIZE option in the MAPSETUP options menu.

Advanced functions in the screen definition menu

You can return to the screen definition menu by pressing **PF3** from any of the map edit menus. Once you have finished editing panes, you may want to save the panes on disk, save the screen definition on disk, or create hard copies. You can do any of these things from the screen definition menu.

Redrawing the entire screen

You can draw or redraw the contents of a screen by pressing **PF12**. This will redraw all panes on the screen.

Saving your work

The MAPSETUP options can be saved by entering

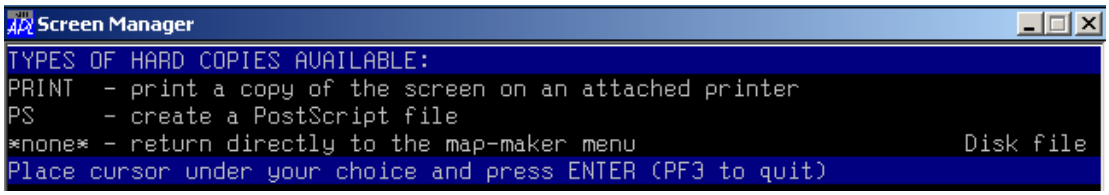
SAVEMAP *legendname*

The options are saved in the C:\PTNMW folder as *legendname*.mst file. To load the map options, function loadmap can be used as follows:

LOADMAP *legendname*

Making a hard copy

When in MapMaker, you can generate a hard copy of the screen at any time by pressing **PF2** in the screen definition menu. Pressing PF2 invokes a menu that looks like this:


Screen Manager
TYPES OF HARD COPIES AVAILABLE:
PRINT - print a copy of the screen on an attached printer
PS - create a PostScript file
none - return directly to the map-maker menu
Disk file
Place cursor under your choice and press ENTER (PF3 to quit)

Hard copy options in MapMaker

There are three ways to generate a hard copy of the contents in the Mapping Window. They are explained below.

1. Print to attached printer: Select *Print* from the *Map* pull down menu at the top left corner of the Mapping Window. Option *Select Printer* lets you change printer.

2. Create Adobe Acrobat file: Select option PS from the menu. Type full path name (including extension .ps) for the file. Once the file is created, use Adobe

Distiller to convert to a .pdf file format. This file could be viewed and printed using Adobe Acrobat.

3. Screen capture: Make sure that the Mapping Window is displayed on top. Press CTRL+ PrintScreen to capture the contents of your monitor screen. Open Microsoft Word or Powerpoint, and paste it on an empty page. Some picture editing (Format Picture) might be necessary. This is a quick and easy method for users who do not have Adobe Acrobat suite, but the quality of the images is compromised.

Exiting from the screen definition menu

To exit from the screen definition menu, press **PF3**. This will return you to the TRGRAPH main menu.

Network Data

Network Storage

The network attributes that constitute a transportation network are stored in APL variables that are brought to the workspace when a network is loaded. The networks share the variable names (for example, link distances are always stored in DIST); hence, only one network can be loaded to the workspace at one time. However, the user can open multiple instances of APL, load TRGRAPH in each of them and load different networks to view them simultaneously.

Recent modifications to the PTNM have resulted in two versions of rail networks. The new version contains additional network features such as smart drawing level (SDLEVEL) and shape points for links. TRGRAPH can handle both versions of the network, but includes certain functions that are specific to the new version. A call to such a function with an older network will exit with an error message.

Table 1 below lists and briefly describes the required variables for rail networks. They correspond to both old and new versions of the network. Tables 2 and 3 list optional variables and additional variables for new network respectively.

Table 1: Required PTNM Rail network variables

Variable Name	Type	Dimensions	Description
COORD	Matrix	(nodes,2)	N^{th} row holds (x,y) coordinates for the n^{th} node. Col 1: x-coordinate Col 2: y-coordinate
DIST	Vector	links	N^{th} element holds distance for the n^{th} link. Values are miles in integer tenths of miles.
FAMILIES	Matrix	varies	Each row defines a group of railroads that are a corporate family and/or have coordinated service. Variable has as many rows as necessary to hold all groups. Variable has as many columns as necessary to hold the largest group.
LINKOWNER	Vector	links	N^{th} element holds code number for the railroad that owns the track for the n^{th} link. For links with multiple owners, it has the index (1000*starting row number + number of rows) into the PARTOWNER matrix.
LINKS	Matrix	(links,2)	N^{th} row holds node pair for the n^{th} link. Col 1: A-node number Col 2: B-node number

MLC	Matrix	(6,links)	Each row holds MLC (mainline code) values for a service type. N^{th} column holds values for the n^{th} link. Service types and associated row are: 1 – General Merchandise 2 – Intermodal 3 – Coal/Bulk 4 – Auto Racks 5 – Double stack 6 – NS (special codes to support custom software developed for NS)
OWNER	Matrix	(n,links)	For the n largest railroads, each row holds 1's (yes) and 0's (no) indicating whether the railroad operates on the link. See TRANS variable to identify the railroad associated with each row.
RRACTIVE	Vector	999	N^{th} element holds 1 (yes) or 0 (no) indicating whether n^{th} railroad is active in the network.
RRALPHAS	Matrix	(1000,4)	$(N+1)^{st}$ row holds character abbreviation for n^{th} railroad.
RRNAME	Matrix	(1000,n)	$(N+1)^{st}$ row holds name for n^{th} railroad.
RRWINDOWS	Matrix	(999,4)	N^{th} row holds coordinates for a map frame that nicely holds the n^{th} railroad. Col 1: start x-coordinate Col 2: x-coordinate range Col 3: start y-coordinate Col 4: y-coordinate range
SHORTLINE	Vector of vectors	varies	Each element holds a vector of link numbers on which a railroad can operate. See TRANS variable to identify the railroad associated with each element.
TRANS	Vector	999	N^{th} element is a pointer to OWNER or SHORTLINE for the n^{th} railroad. Values 1-999 are pointers to the k^{th} row of OWNER. Values 1001+ are pointers to elements of SHORTLINE. (Pointer is value minus 1000).
LINKSTATE	Vector	links	N^{th} element holds 2-digit FIPS code for state in which n^{th} link is located.

Table 2: Optional PTNM Rail network variables

Variable Name	Type	Dimensions	Description
DISTTYPE	Vector	2	Abbreviation for distance units to use for map labeling and text reports.
KEYNODES	Matrix	(varies,2)	Holds node numbers for prominent locations to use for labeling on maps. Col 1 – node number. Col 2 – importance factor (1-9).
LINKDIR	Vector	links	N^{th} element indicates bi-directional or unidirectional train operations permitted on the n^{th} link. Values are: 0: unidirectional in A-node to B-node direction. 1: bi-directional.
MILERATIO	Scalar	null	Conversion factor for screen coordinate units to miles
NETBNDS	Vector	varies	Name of function to use as default for geographic boundary display on maps.
NETDFLTS	Vector	5 or 6	Holds default values to use during process of adding links to a network. Elements are: 1 – Default MLC value 2 – Default LINKSTATE value 3 – Default railroad for new links 4 – Default RNUM value (used in highway networks) 5 – Default LINKDIR value 6 – Default SDLEVEL value (new version of rail network)

Table 3: Additional variables for new PTNM Rail network

Variable Name	Type	Dimensions	Description
SDLEVEL	Vector	links	N^{th} element holds the Smart Drawing Level for n^{th} link. Values may be 1,2 or 3
NIV	Vector	nodes	N^{th} element contains an importance number (0 – 9999) that has been assigned to n^{th} node. This represents the distance from the node to the next more important node
OPIMP	Vector	nodes	N^{th} row holds node operating importance info for n^{th} node. Values may be 0-9
SIZEIMP	Vector	nodes	N^{th} row holds node size importance info for n^{th} node. Values may be 0-9

LOPVAR	Matrix	(varies,10)	Holds Carrier Specific Link Attributes 1 – Link ID 2 – Carrier ID 3 – Type of Operation (1 – trackage rights; 2 – haulage rights) 4 – MLC 1 5 – MLC 2 6 – MLC 3 7 – MLC 4 8 – MLC 5 9 – MLC 6 10 – Direction Flag Note: This variable has Carrier Specific Attributes for secondary carriers (with operating rights), not for primary carriers (owners).
PARTOWNER	Matrix	(varies,3)	Holds the Owner information for links with multiple owners 1 – Link ID 2 – Carrier ID 3 – Percentage Ownership (2 digit integer) Note: ensure total % per link is 100
SHAPEFLAG	Scalar	null	Indicates if Shape Data is available for network 0 – No 1 – Yes

In addition to the APL variables, some network data are stored as separate files on disk. The file names are stored in variables, mentioned below along with a description of their contents.

Node Names File (*.nms)

Network variable name: NAMEFILE

Field	Length	Description
1	13	City Name
2	2	State/Province Abbreviation

Note: $(n+1)^{st}$ record of file holds node name for n^{th} node.

Stations File (*.spl)

Network variable name: SPLCFILE

Field	Length	Description
1	6	SPLC Code for Station
2	3	Railroad Code for Station
3	5	FSAC Code for Station
4	13	Station Name
5	2	State/Province Abbreviation
6	5	Node Number
7	9	ERPC

Note: Railroad Code/FSAC Code combination is unique key for file. File is sorted by SPLC Code.

Rule 260 Master File (jct*.260)

Network variable name: JCTFILE

Field	Length	Description
1	5	Rule260 Junction Alpha
2	6	SPLC
3	27	Junction Name
4	2	Junction State Abbreviation
5	5	Node Number
6	1	Active/Inactive Flag

Shape Data (*.shp)

Network variable name: SHAPEFILE

Field	Length	Description
1	10	X Coordinate
2	10	Y Coordinate

Node/SPLC Index File (*.sp4)

Network variable name: NSFILE

Field	Length	Description
1	4	SPLC Code (first 4 digits) with a Station Assigned to the Node
2	4	SPLC Code (first 4 digits) with a Station Assigned to the Node
3	4	SPLC Code (first 4 digits) with a Station Assigned to the Node
4	4	SPLC Code (first 4 digits) with a Station Assigned to the Node
5	4	SPLC Code (first 4 digits) with a Station Assigned to the Node

Note: n^{th} record holds entry for n^{th} node.

Railroad Names File (*.rrn)

Network variable name: RRNFILE

Field	Length	Description
1	x	Railroad Name (full spelling)

Note: File has 1,000 records. $(n+1)^{st}$ record of file holds railroad name for n^{th} railroad (based on AAR railroad code number).

Shape Pointer File (Shp*.ptr)

Network variable name: SHPPTRFILE

Variable Name	Type	Dimensions	Description
SHAPEΔPOINTER	Vector	links	N^{th} element is a pointer to the Shape Data file for the nth link. Value is the (starting row number*100) + (number of rows)

Pointers File (*.ptr)

This file holds a group of APL variables in APL-encoded format.

Network variable name: POINTFILE

Variable Name	Type	Dimensions	Description
SPLCΔPOINTER	Vector	9999	N^{th} element is a pointer to the Stations File for the n^{th} 4-digit SPLC. Value is the (starting row number*1000) + (number of rows).
SPLCΔPTR2	Vector	100	N^{th} element indicates the beginning record number and number of records for that 2-didgit SPLC in the SORTSPLC file
SHAPEΔPOINTER	Vector	links	N^{th} element is a pointer to the Shape Data file for the nth link. Value is the (starting row number*100,000) + (number of rows)
RRΔPOINTER	Binary Matrix	1000,100	Position of '1's in the n^{th} row indicates the 2-digit SPLCs served by the $(n-1)^{th}$ railroad
GEOΔSTATEALPHAS	Matrix	57,2	N^{th} row contains the 2 character state abbreviation for that LINKSTATE in US

CANΔSTATEALPHAS	Matrix	13,2	N^{th} row contains the 2 character state abbreviation for that (LINKSTATE-80) in Canada
MEXALPHA	Matrix	33,2	Contains the 2 character state abbreviation for that States in Mexico – not used currently

Network Editing

Introduction to Network Editing

TRGRAPH workspace contains many APL functions that can be used to modify and update PTNM rail, highway, and waterway networks, as well as create and edit other transportation networks.

What is Network Editing

Network editing constitutes altering the contents of any of the variables or disk files mentioned in the previous chapter. There are several ways to edit a network. You can edit the variables directly from the TRGRAPH workspace window using either APL primitive operators or functions (refer to Chapters 3 and 4 in the Language Reference User Manual for Dyalog APL/W) or user-defined APL functions.

Variables could be written to text files using READFIX, and edits could be made using text editor applications such as NotePad or TextPad. These files could be read back into APL variables using WRITEFIX.

However, a popular and less-clumsy way to browse and edit network attributes is by using user-friendly TRGRAPH functions, mentioned in the following sections.

Uses of Network Editing

With the network-editing functions, you can input proposed changes to a transportation system in order to assess the costs and benefits of your proposals. For example, a new rail line could be added to a rail carrier's system, permitting a "what-if" analysis of resulting changes in traffic flow.

The functions also provide a mechanism to input important network changes prior to receiving the next PTNM update. These include temporary changes, such as a track washout or a bridge collapse, as well as permanent changes, such as the opening of a new interstate highway.

Loading a network

A pre-existing network can be loaded to the workspace using any of the following ways:

1. Use function LOADNET. If you know the name of the network to be loaded, type

    LOADNET *netname*

where *netname* is the name of the network, without the prefix RWY/HWY/WWY.

2. Use function PICKNET. If you do not know the exact name of the network that you want to load, type

PICKNET

This opens a pick file menu, and lets the user browse and pick a network file for loading. The network file names have prefix RWY/HWY or WWY to indicate type of network, and they have file extension ".ntw".

3. Use Mapping Window. Choose *Load Network* from *File* drop down menu at the top left corner of the Mapping Window for a call to function PICKNET.

Saving a network

To save a network from the workspace to a disk file, call function SAVENET. A file save box opens and lets user choose directory and file name for the network. If the user-entered filename already exists, it prompts the user before replacing it with the new network. Alternatively, *Save Network* option from *File* drop down menu in the Mapping Window could be used for the same.

Controlling the screen display

Following are the functions that let the user change display on the Mapping Window. They can be called from the TRGRAPH workspace window, from the command line of any PTNM tool, or from a user-defined APL function executed in TRGRAPH workspace.

ZOOM

ZOOM allows you to dynamically change the geographic area shown on the screen. A small rectangle appears in the Mapping Window, which can be moved with the mouse. Choose a rectangular area by clicking the mouse once from one of the corners and again from its diagonally opposite corner. The image on the Mapping Window will be redrawn with this zoomed-in area, keeping the aspect ratio constant.

RETREAT

RETREAT will enlarge the virtual window area by a factor of 2. The area just outside the window edges can be viewed.

ADVANCE

ADVANCE will reduce the virtual window area by a factor of 2. The central part of the screen is enlarged and the area near the window edges will disappear from view.

REFRESH

REFRESH allows you to redraw the screen, incorporating any changes that you have made. For example, if you change any of the parameters on the map edit menu, a call

to REFRESH permits you to see the results of your changes. This function can also be called using PF12 key from any PTNM tool menu.

ERASE

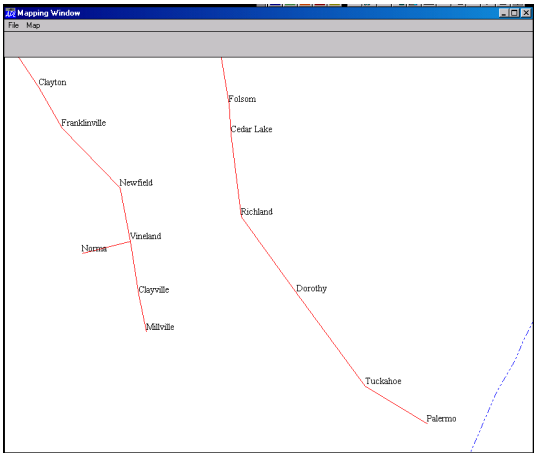
ERASE clears the Mapping Window. This function can also be called from the Map pull down menu in the Mapping Window.

Working with links

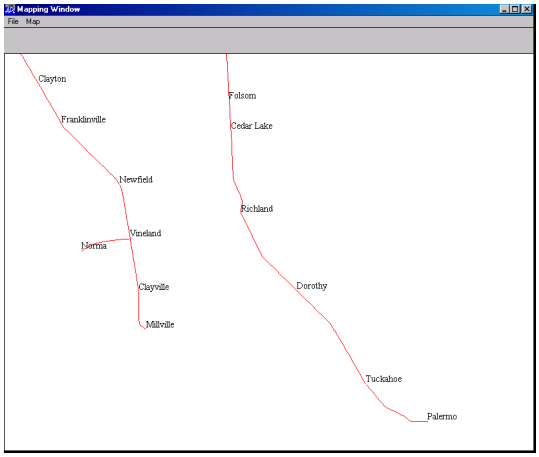
Links are the segments connecting two nodes. Depending on the type of transportation network with which you are working, links can represent rail lines, roads and highways, or waterways.

Links related network data are stored in the network variables LINKS, DIST, MLC, SDLEVEL, LINKSTATE, LINKOWNER, PARTOWNER, OWNER, SHORTLINE and TRANS. LINKOWNER and PARTOWNER have information about the owner of the tracks, whereas OWNER, SHORTLINE and TRANS together contain information about the operators on the tracks.

Another link attribute is the set of shape points that define the shape of the link, or the curve of track segment it represents. Without shape points, links are displayed as straight lines, whereas, links displayed with shape points reflect the actual shape of tracks. The following figures illustrate this.



Without Shape Points



With Shape Points

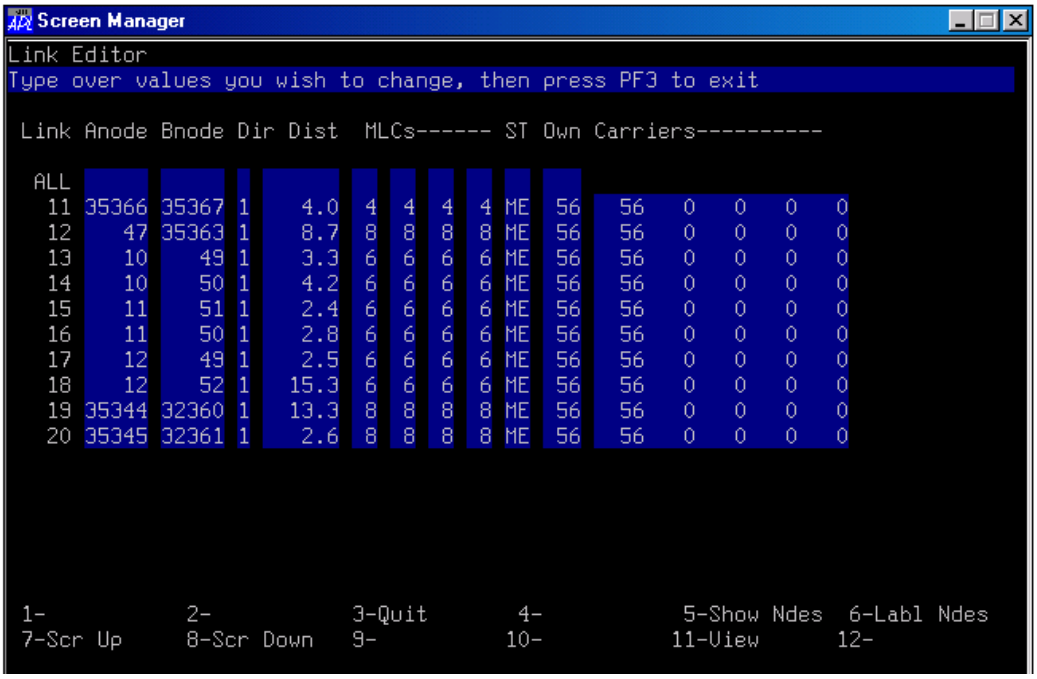
The shape point data is stored in disk files, and is read into workspace variable SHPMAT when required. SHAPEFLAG variable indicates if shape data is available for the network. ΔSHAPESON is assigned 1 to display links with shapes points. Shape points can be edited using function SHPEDIT.

Other link attribute values can be viewed and edited using LINKEDIT called from the TRGRAPH workspace window.

LINKEDIT *lks*

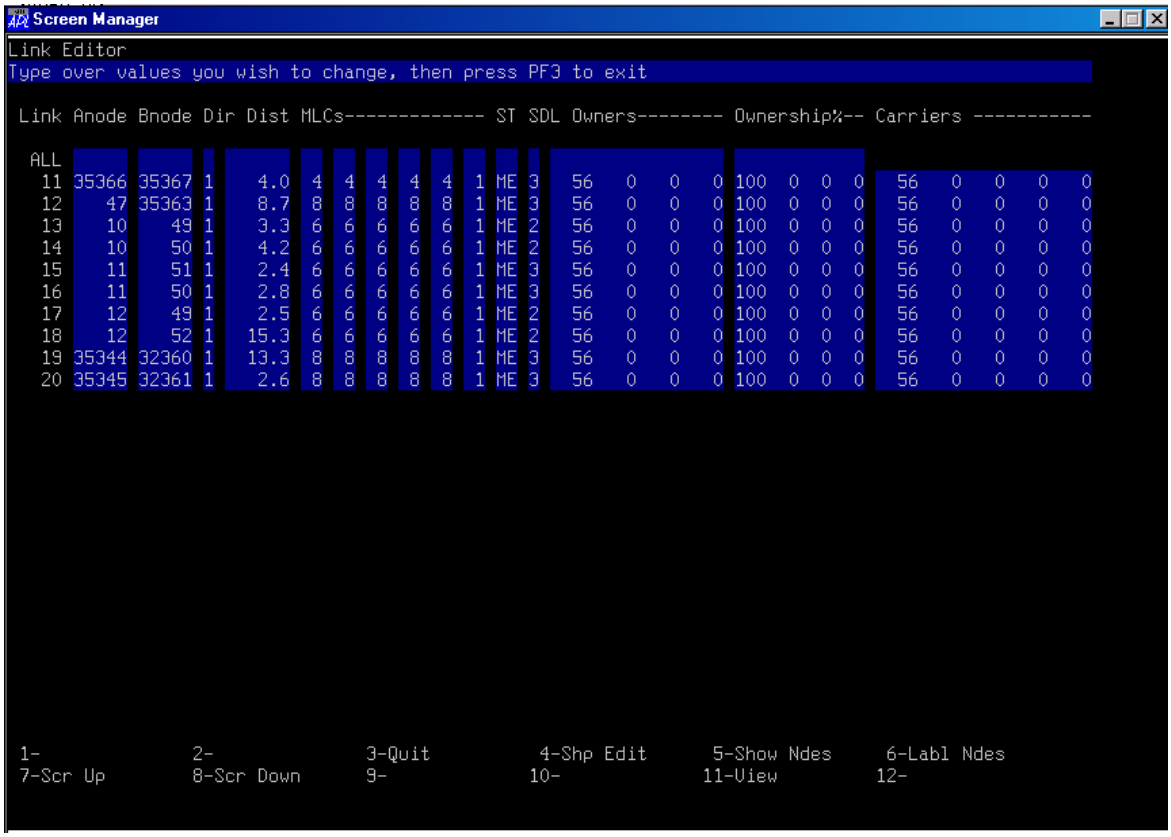
where *lks* is one or more link numbers.

If the network loaded in the workspace is of the old version, the LINKEDIT menu looks like the figure below.



LINKEDIT menu for old version rail networks

LINKEDIT menu for a new network looks like the following figure.



LINKEDIT menu for a new railroad network

To edit any attribute for a link, place cursor in the corresponding field and change its value. To change an attribute for all links displayed in the window, place cursor in first row (Link field value is ALL) of corresponding field and type the new value.

LINKEDIT makes changes to the network variables in the workspace. The network has to be saved before exiting workspace, or the changes will be lost.

Links can be selected for editing using the GETLINKS tool.

GETLINKS *linkset*

displays a menu next to the mapping window and lets the user manually select links from the set of links *linkset*. With the help of the mouse, the user chooses links to be selected (or discarded from selection) using a movable cross-wire displayed on the mapping window. Selected links are highlighted in magenta, and discarded links are shown in black. The user types 'E' to complete selection. The function returns the link numbers of the selected links to the TRGRAPH workspace window. The output could be directed to a variable for use later, for example

LKS ← GETLINKS LINKSINWIN

or

LINKEDIT GETLINKS LINKSINWIN

where LINKSINWIN is another TRGRAPH function that selects all links in the virtual mapping window. This and other functions used for link related network editing are listed below:

1. *rr* ADDLINKS *lks* – adds links *lks* to carrier *rr*
2. *rr* ADDNEWLINK *nds* – creates a new link on *rr* between pairs of nodes *nds*
3. ASSIGNDIST *lks* – assigns distance to links *lks* based on straight-line
4. CHLINKS *nds* – returns links connecting *nds*
5. *rr* DROPLINKS *lks* – drop links *lks* from carrier *rr*
6. GETSHP *lks* – returns shape points for links *lks*. The output is a four column matrix with the following format:

   Link# Shape Point# X-coordinate Y-coordinate

   The coordinates of end nodes are also included at the top and bottom of each set of shape points for the link arranged in a sequential manner from Node A to Node B. Node A is the first element of the corresponding row in variable LINKS, and Node B is the second element in the same row. If a link AB has five shape points, there are seven records in the output. The first record has

Shape Point# as 0 and has the coordinates for node A. The following five records have coordinates for shape points 1 to 5. The last record has Shape Point# 6 has the coordinates for Node B.

The read shape points are saved in the global variable SHPMAT in order to save time during subsequent reads of the same data. Changes to this variable can be committed to disk using function SAVESHP.

7. LABELDIST *lks* – labels link distances of links *lks*

8. LABELINKS *lks* – labels link numbers of links *lks*

9. LINKSINWIN – returns links in mapping window

10. LINKSONRR *rrs* – returns links on carriers *rrs*

11. SELECT *rrs* – returns link on carriers *rrs*

12. SHOWLINKS *lks* – displays links *lks*. If ΔSHAPESON is 1 and if SHAPEFLAG is 1, this function displays links with shapes points. The default value of ΔSHAPESON is 0 in TRGRAPH workspace. SHAPEFLAG is a network variable and is loaded with the network.

13. SHPEDIT *lks* – displays and lets user edit shape points for links *lks*. This function edits the Shape Data file on disk directly. Hence, it is prudent to keep a backup of the disk file before calling this function. However, the SHAPEΔPOINTER variable has to be saved separately using function SAVESHPΔPTR before exiting workspace. If you save the file with a different name, update the SHPPTRFILE variable before saving the network.

14. SPLITLINK *lk* – lets user manually split link *lk*

A complete list of TRGRAPH functions is available in last chapter of this manual. An example of a network edit process is given in the last section of this chapter.

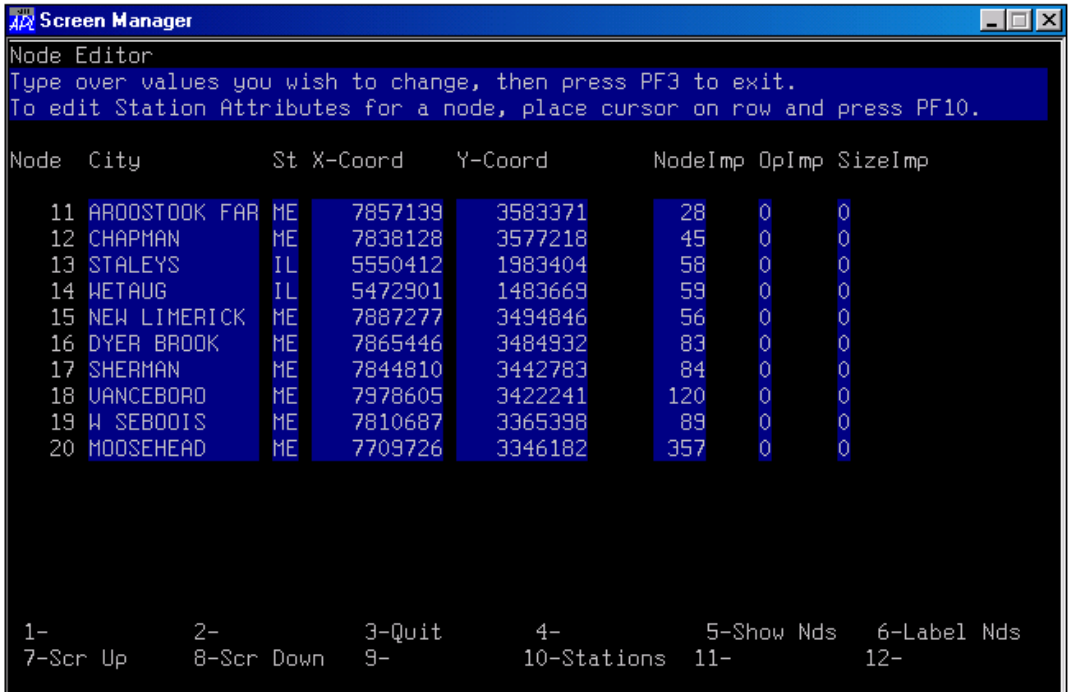
Working with nodes

Nodes represent points, such as cities, junctions, intersections, and ports on the rail, highway, and waterway networks.

Node related network data are stored in variables COORD, NIV, OPIMP and SIZEIMP. Node names, station and junction information are stored in separate files on disk.

The node attribute variables can be viewed and edited using function NODEEDIT, similar to LINKEDIT. The variables are updated in the workspace and will be lost if the user exits from workspace without saving network. Changes made to the City and State names are restricted to the workspace. To change node names permanently, the Node Names file on disk has to be edited.

The figure below shows the NODEEDIT menu.


Screen Manager
Node Editor
Type over values you wish to change, then press PF3 to exit.
To edit Station Attributes for a node, place cursor on row and press PF10.
Node City St X-Coord Y-Coord NodeImp OpImp SizeImp
11 AROOSTOOK FAR ME 7857139 3583371 28 0 0
12 CHAPMAN ME 7838128 3577218 45 0 0
13 STALEYS IL 5550412 1983404 58 0 0
14 WETAUG IL 5472901 1483669 59 0 0
15 NEW LIMERICK ME 7887277 3494846 56 0 0
16 DYER BROOK ME 7865446 3484932 83 0 0
17 SHERMAN ME 7844810 3442783 84 0 0
18 VANCEBORO ME 7978605 3422241 120 0 0
19 W SEBOOIS ME 7810687 3365398 89 0 0
20 MOOSEHEAD ME 7709726 3346182 357 0 0
1- 2- 3-Quit 4- 5-Show Nds 6-Label Nds
7-Scr Up 8-Scr Down 9- 10-Stations 11- 12-

NODEEDIT menu

Nodes can be selected from the Mapping Window using the function GETNODES, similar to GETLINKS.

GETNODES *nodeset*

displays a menu next to the mapping window and lets the user manually select nodes from the set of nodes *nodeset*. With the help of the mouse, the user chooses

nodes to be selected (or discarded from selection) using a movable cross-wire displayed on the mapping window. Selected nodes are labeled on screen. The user types 'E' to complete selection. The function returns node numbers of the selected nodes to the TRGRAPH workspace window. The output could be directed to a variable for use later, for example

NDS ← GETNODES NODESINWIN

or

NODEEDIT GETNODES NODESINWIN

where NODESINWIN returns nodes numbers in the mapping window. This and other node related functions helpful in network editing are listed below. These functions can be called from the TRGRAPH workspace window or from the command line of any PTNM tool.

1. ADDNEWNODES – add new nodes using menu at user selected cursor positions
2. ADDNODES *c* – add new nodes at coordinates *c* (*x*,*y*)
3. *fsac* CHANGEFSAC *nde* – moves FSAC *fsac* to node *nde*
4. *nds* CHANGENAME *phrases* – changes node names for *nds* to *phrases*
5. *splc* CHANGESPLC *nde* – changes SPLC at node *nde* to *splc*
6. CHLINKS *nds* – returns all links connected to *nds*
7. GETNAMES *nds* – returns City, State names of the nodes *nds*
8. LABEL *nds* – labels *nds* in the mapping window
9. *code* NAMESFOR *nds* – returns node attributes or just city, state depending on the value of *code*
10. NODEFOR *names* – returns node numbers for city, state *names*
11. NODEPAIRS *lks* – returns 2-col matrix (anode,bnode) for links *lks*
12. NODESINWIN – returns nodes in mapping window
13. NWINDOW *nds* – sets mapping window to just hold *nds*
14. SHOW *nds* – labels node numbers of nodes *nds*
15. SHOWNODES *nds* – places a triangle at the locations of nodes *nds*

A network edit process, using the functions described so far, is illustrated in the next section. A complete list of TRGRAPH functions is available in last chapter of this manual.

Example in network editing

Suppose you want to study the effect of not letting trains with Auto Racks use CSXT tracks between Newark, DE and Arden, DE. You would do this by creating a second network with very high MLC values for service type 4 for links between these two locations, and comparing routes on this network with those on the original.

The following steps illustrate one method of creating the new network.

1. Load TRGRAPH and original rail network (say RWYBASE.ntw)

)LOAD TRGRAPH

   LOADNET ‘BASE’

2. Change virtual window to show Delaware and draw US boundary.

   STATEWINDOW ‘DE’

   USMAP

3. Label the two cities and show CSXT tracks. Zoom in to this area.

   LABEL ‘NEWARK DE¨ARDEN DE’
   (¨ is generated by pressing Ctrl + 1)

   ‘RED’ SHOWLINKS LINKSONRR ‘CSXT’

   ZOOM
   (manually choose the new virtual window to include both cities)

4. If you find that the labels are too small to read, you can change the font size (default is 0.6) and redraw. You do not have to Zoom again, because the window remains the same even if you erase the screen.

   ΔSCL ← 1

   ERASE

   ‘RED’ SHOWLINKS LINKSONRR ‘CSXT’

   LABEL ‘NEWARK DE¨ARDEN DE’

5. You might notice that Newark is on a different track than Arden. The reason for this is that Newark, like many cities, has several nodes with the same name. To see the correct node, you can display all the station names on CSXT in the window.

LABEL NODESONRR ‘CSXT’

Now you can see another Newark station on the western line that goes through Arden. To see the exact location of these stations, SHOWNODES is used. It puts a small triangle at each node.

SHOWNODES NODESONRR ‘CSXT’

6. Choose links to be modified using GETLINKS. A separate menu appears next to the Mapping Window. Move cross-wires to link using mouse and press Enter or press Space Bar or left-click mouse to select link. Select the eight links between Newark and Arden on the western line. Enter ‘E’ after completing selection.

   LKS ← GETLINKS LINKSONRR ‘CSXT’

7. Check if LKS has the correct number of links.

   ρLKS
   should output 8.

8. View links attributes of the eight selected links.

   LINKEDIT LKS

9. Change MLC for Auto Racks service to 99 for these links. Place cursor on the fourth column of MLC fields for each link and change value to 99. Alternatively, you can place cursor in the first row (ALL links) and type 99. This will change the MLC(4) value to 99 for all links in the LINKEDIT window. Exit LINKEDIT (Press PF3).

10. Save network with new name (say CASE1).

    SAVENET

    Type CASE1in the field for file name. Network will be saved as RWYCASE1.ntw.

TRGRAPH command language

Introduction

TRGRAPH contains its own rich command/macro language, which the experienced user can use to construct specialized applications or preformed specialized analyses. The full Dyalog APL/W language is also available to you from the TRGRAPH workspace window and from the command line on PTNM menus.

A brief introduction of the APL language, along with examples specific to TRGRAPH workspace, is included in this section.

Command syntax

Function arguments

A function is a one-word command which tells the computer to do something (draw a map, add two numbers, etc.). Some functions have no user inputs (arguments). These are called *niladic,* which means "no arguments". These are entered all to themselves in a single line. NAMAP is an example of a niladic function:

```
NAMAP
```

This function does exactly one thing: it overlaps a map of North America on the screen, in whatever screen and virtual windows are currently set.

Another group of functions needs a single argument which gives the function necessary additional information on what to do. These are called *monadic*, meaning one (mono) argument. The argument to a monadic function is called a "right argument" because it is typed to the right of the function name. STATEMAP is an example of a monadic function:

```
STATEMAP 'NJ'
```

This function will draw a map of the state(s) given in quotes as its right argument. Because of their much greater flexibility, most of the functions in TRGRAPH are monadic.

In TRGRAPH there are some functions which have both left and right arguments. These are called *dyadic*, meaning two arguments. SHADESTATE is an example of a dyadic function, as it takes state names as its right argument, and a shading parameter as its left argument:

```
3 SHADESTATE 'NJ'
```

Optional left arguments

In some dyadic functions specifying a left argument is optional. In functions where left arguments are optional, the function assumes a default value for the left argument if it is omitted. OVERLAY is an example of a dyadic function with an optional left argument.

```
OVERLAY 'BNSF'
```

would draw the Burlington Northern Santa Fe network in the default (solid black) line-type.

```
'DOT RED' OVERLAY 'BNSF'
```

would draw the Burlington Northern Santa Fe network with a dotted red line-type.

Using quotation marks to enter character data

In TRGRAPH, you input character data as a string of characters surrounded by single quotation marks. The single quotation marks on input are punctuation and indicate the presence of a character. They are not part of the data and so are not displayed when APL displays the character data. Quotation marks distinguish character data from function names that are also strings of characters.

If the character you want to enter is itself a single quotation mark, you must double it and then put it within a pair of delimiting quotation marks. That is, to write a scalar character quote, you must enter four quotation marks (the character quotation mark doubled and the required surrounding quotation marks).

Argument syntax

Depending on the function, arguments can be scalars, vectors, or matrices. Some functions can handle character data and others which perform arithmetic operations can handle only numerical data. Other functions can handle either character or numerical data. Many TRGRAPH functions use certain general types of syntax. These are as follows:

Carriers

Carriers can be entered as arguments in TRGRAPH as follows:

0	All carriers in the network
712 555	Carriers whose numbers are 712 or555
'UP NS CSXT'	Carriers whose initials are “UP”, “NS” or “CSXT”
FAM 'UP'	Family of the carrier whose initials are “UP”
FAM 400 8	Family of the carriers whose numbers are 400 or 8
ALLBUT FAM 'UP'	All carriers EXCEPT the family of “UP”
ALLBUT 802	All carriers EXCEPT the one whose number is 802

States/provinces

States and provinces can be entered as function arguments using the following varieties of syntax:

'WV'	West Virginia.
'NJFLTX'	New Jersey, Florida, and Texas

'NJ FL TX'	New Jersey, Florida, and Texas
'NJ, FL, TX'	New Jersey, Florida, and Texas
4 6	Arizona and California (which have the FIPS codes 4 and 6 respectively)
'MB'	Manitoba

Links

A network link is a section of railroad track, waterway, or road between two cities (nodes). A link can be specified by either a unique link number or by the two node numbers defining the end points of the link. Link numbers can be specified using scalar, a vector, or a matrix with an odd number of columns, containing the link number in column one. If links are defined as two node numbers, they must be specified in a matrix with an even number of columns, containing the A node in column 1 and the B node in column 2.

14302	Link number 14302
16434 16435	Links numbered 16434 and 16435
1 2 ρ 16434 16435	Link defined by nodes 16434 and 16435 ("rho" is shift-R on the APL keyboard)
LINKSONRR 'NS'	All links on Norfolk Southern
LINKSINWIN	All links in current virtual window

Nodes

Nodes in TRGRAPH represent locations. Each node has a node number, and may have an associated city name. TRGRAPH functions will recognize either the city name in quotes or the node number. A spelling helper is available to assist spelling city names.

16434	Node number 16434.
'CHARLESTON WV'	Charleston, West Virginia.
'PIT* PA'	Cities in Pennsylvania, whose names start with the letters PIT
'NEWARK NJ,BOSTON MA'	Newark, New Jersey and Boston, Massachusetts
16434 12999	Nodes 16434 and 12999

Draw triplets

The low-level TRGRAPH graphics functions (such as the function DRAW) accept a type of argument called a *draw triplet*. The first element of the triplet is a flag, the second element is an X (horizontal axis) coordinate, and the third element is a Y (vertical axis) coordinate.

The draw flags are encoded with information when viewed in *binary* (base 2) form. The meaning of the right-most binary digit is:

0	move to (on a pen plotter, raise the pen up and move to)
1	draw to (on a pen plotter, lower the pen to the paper and draw to)

Each successive binary digit also means something, such as coordinate system, relative or absolute, line or pattern style, and color.

Draw triplets can be specified in an array of any shape, but for convenience are generally stored in matrices with three columns.

There is a class of TRGRAPH functions which can be used to encode information in the draw flag. Several of these functions are used in the examples which follow:

0 100 150 1 200 300	A line connecting the point (100,150) with the point (200,300) in the absolute screen coordinate system
0 100 150 9 100 150	The same line, where the second triplet contains relative screen coordinates i.e. relative to the previous triplet, rather than to the origin (0,0)
'RED' COLOR 0 100 150 1 200 300	The same line, drawn in red
2 LTYP BLINK 0 100 150 1 200 300	The same line, drawn in line style two (dotted), and blinking (only certain PTNM workstations support blinking)

Function results

Explicit results

A function returns an explicit result if the function header assigns the result to a variable using the APL left assignment arrow. The function header is the first line of the function.

Any of the three function types (niladic, monadic, or dyadic) may return an explicit numerical or character result that, unless it is assigned to a variable name or used as a

right argument to another function, will be displayed on the screen. For example, LINKSINWIN is a niladic function that returns numbers for network links in the current window. Used alone, LINKSINWIN will type out on the screen the link numbers of the links in the current window (this can be a very long list!). More usefully, LINKSINWIN can be used as a right argument to the monadic function SHOWLINKS to draw the links in the current window:

```
SHOWLINKS  LINKSINWIN
```

A whole series of functions which need arguments and return results can sometimes be strung together to form a meaningful sentence or *expression*. For example, the following expression will draw the state of Nebraska in dashed red lines:

```
DRAW 'RED' COLOR 2 LTYP STATEBNDS 'NE'
```

Assigning explicit results to variables

A variable is a name that represents a value. The value represented by the variable may be changed. For example, the variable A may have the value 100 or the value 2.1, depending on what is assigned to it. To assign the variable A a value 100, type in:

```
A ←100
```

The symbol "←" is called the assignment arrow. It is left-pointing and can be read "is assigned". The expression to the right of the arrow may be any valid APL expression, including the results of functions which give explicit results. For example:

```
A ← LINKSINWIN
```

would assign to the variable A a vector containing the link numbers of the links in the current window.

Summary of function syntax

You can look at the function header (first line of the function) to determine its calling syntax, by comparing it with the following chart:

Syntax	Type of function	Explicit Result
NAMAP	Niladic	No
A ← LINKSINWIN	Niladic	Yes
STATEMAP ST	Monadic	No
A ← STATEBNDS ST	Monadic	Yes

N SHADESTATE ST	Dyadic	No
VOL ← RR GETVOL FILE	Dyadic	Yes

The comment at the top of a function will describe what each argument is and whether the left argument of a dyadic function is optional or not.

Writing your own functions

In creating a presentation map, one typically needs to call more than one function. If the same map or map type is to be drawn over and over again, one can save keying time by writing a function which will execute several commands by typing in just one word.

For example, consider the following set of commands which would create a map of the Burlington Northern Santa Fe railroad with a legend. It is assumed here that the network is already loaded, the window is already set, and that MAPSETUP has been called to set the legend parameters:

```
WINDOW FAM 'BNSF'
USMAP
OVERLAY  FAM  'BNSF'
LABELCITIES  FAM 'BNSF'
BORDER
SHOWLEGEND
```

The above commands will be executed when the function is called.

Function editors

Function editors in the Dyalog APL/W environment can be invoked by typing system command

)ED *FNAME*

where *FNAME* is the name of the function to be edited. If function FNAME does not exist in the workspace, a new function with that name is created. The function is saved in the workspace by selecting option Fix in the File dropdown menu, or by exiting the editor after saving (Exit option). Option Abort exits the editor without saving function.

The function is saved only in the workspace and will be lost if the user exits from the APL session without saving the function to a disk file using SAVEFN described in the next section.

Order of Operation

APL has a greater variety of functions than many other programming languages. Therefore, to avoid complicated hierarchy of order in which operations are performed, there is no hierarchy. Instead, APL always executes expressions from right to left.

As in other languages, parentheses may be used to change the order of operation.

Branching and looping

Both branching and looping can be accomplished in TRGRAPH functions using the branch symbol →. A branch can be unconditional, always branch to a specific location or conditional and branch only if a statement is true. The destination location for a branch (where we are branching to) can be defined in three ways. First, a branch can be to a statement label (for example, SKIP:). Second, a branch can be to a specific line number in the program. The problem with using line numbers is that adding and deleting lines in the program will renumber the lines but not change the branches. The third method is to branch a specific number of lines above or below the current line. The safest and most widely used method is to branch to a statement label.

An example of a branch statement is:

```
→ (A=5)/END
```

This is a conditional branch based on A reaching the value of 5. When A is equal to 5, the program will branch to the line with the label END.

Looping in APL is accomplished by continually branching to a section of code until a specific condition is met. For example:

```
LOOP: → (10=I)/END
I ← I + 1
→ LOOP
END: 'PROGRAM SUCCESSFULLY COMPLETED'
```

This program will test the statement: the variable I is equal to 10. If it is true, the program will branch to END and print the words “PROGRAM SUCCESSFULLY COMPLETED”. If the statement ‘I equal to 10’ is false, the program will move to the next line which adds 1 to I and then performs an unconditional branch to the line labeled LOOP. When I equals 10, the program will end. Note that in this example if I has an initial value greater than 10 an infinite loop will occur.

TRGRAPH (and APL) commands are *interpreted* not *compiled*, so code which loops will be less efficient than code that does not loop. For efficiency, try to use a TRGRAPH or APL syntax that does not require looping. Loop only as a last resort.

Saving your work

Saving functions and variables in files

When a function is created, it is only saved in the workspace for the duration of the workstation session. It is not written to disk and therefore will disappear when you log off. To write a function to disk so that you can use it in future sessions, the function SAVEFN should be used, which takes as its right argument the name of the function to be saved in quotes. For example:

```
SAVEFN  'TEST'
```

would save the function TEST to a disk file with file name TEST and file extension '.afn'. To read in a saved function at your next session, the function LOADFN should be used, as in:

```
LOADFN  'TEST'
```

to read in the function TEST.

When a variable is created, it is also only saved in the workspace for the duration of the session. It is not written to disk and therefore will disappear when you log off. To write a variable to disk so that you can use it in future sessions, the function SAVEVARS should be used, which takes as its right argument the name of the output file in quotes and as the left argument the variable name(s) in quotes. For example:

```
('SMALLMAP'  'SMALLMAP2')  SAVEVARS  'TEMP.DCF'
```

To read in a saved variable(s) at your next session, the function LOADVARS should be used, as in:

```
LOADVARS 'TEMP.DCF'
```

to read in the variables stored in the file TEMP.DCF.

Character matrices from APL can be saved as text files on disk using function WRITEFIX. To convert an APL variable to character format, an operator with symbol ⍠ is used. For example, the contents of the two-column matrix LINKS is written to a text file using

```
( ⍠ LINKS) WRITEFIX 'LINKS.TXT'
```

The file can be read into the workspace and assigned to the variable by

```
LKS ← READFIX 'LINKS.TXT'
```

LKS will be a character matrix and not two columns of numbers. It will have as many columns as there are characters in each row of LINKS.TXT. To convert the character matrix to a matrix of numbers, functions CHARΔTOΔNUM can be used. For example:

```
LKS ← CHARΔTOΔNUM READFIX 'LINKS.TXT'
```

However, this function will not work correctly if the columns are not easily identifiable. In that case, the columns are explicitly defined as arguments using function CHAR2NUM. For example:

```
LKS ← 5 0 5 0 CHAR2NUM READFIX 'LINKS.TXT'
```

where LINKS.TXT has 2 columns of 5 digit integer numbers. Suppose the last two digits of each field are decimal places, then 5 2 5 2 is used as the left argument.

Alternatively, the variable could be saved as an APL file using function WRITEAPL. The file is saved with extension '.DCF', and can be read in using READAPL. These two functions are similar to WRITEFIX and READFIX.

Saving applications as packages

TRGRAPH provides a way to save a group of functions and variables as an application *package*.

```
LST  SAVEPKG  'PKGNAME'
```

will save the package described in LST as a package on disk. PKGNAME will be the file name of the output package. LST is an optional left argument which is a character matrix containing a list of the contents of the package. If omitted, the function will look for the variable PKGNAME. Each row specifies an item in the package in columns 3 and following. Column 1 contains one of the following codes for each item:

N	the first line in the list and is the name of the variable in which the list will be stored when reloaded.
V	variable to be saved in the package file
F	function to be saved in the package file
D	function saved to disk (using SAVEFN) but not saved in the package file, but will be loaded into the workspace when the package is loaded.
L	(optional) the final entry in the list and is the latent expression to be executed when the package is loaded.

Column 2 should be left blank.

LOADPKG 'PKGNAME'

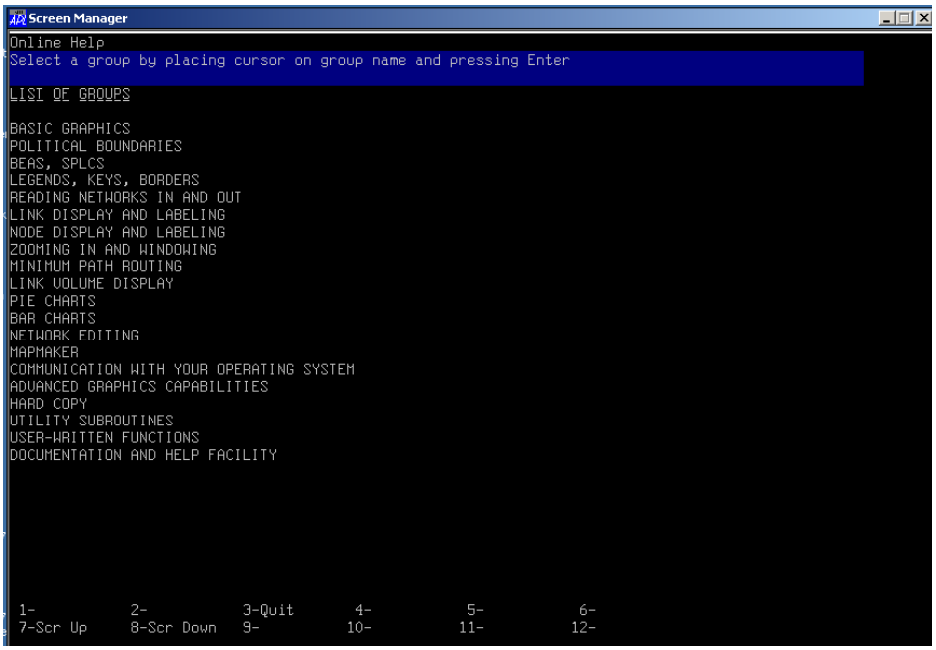
will load the package into the workspace and execute its latent expression, if any.

Help facility

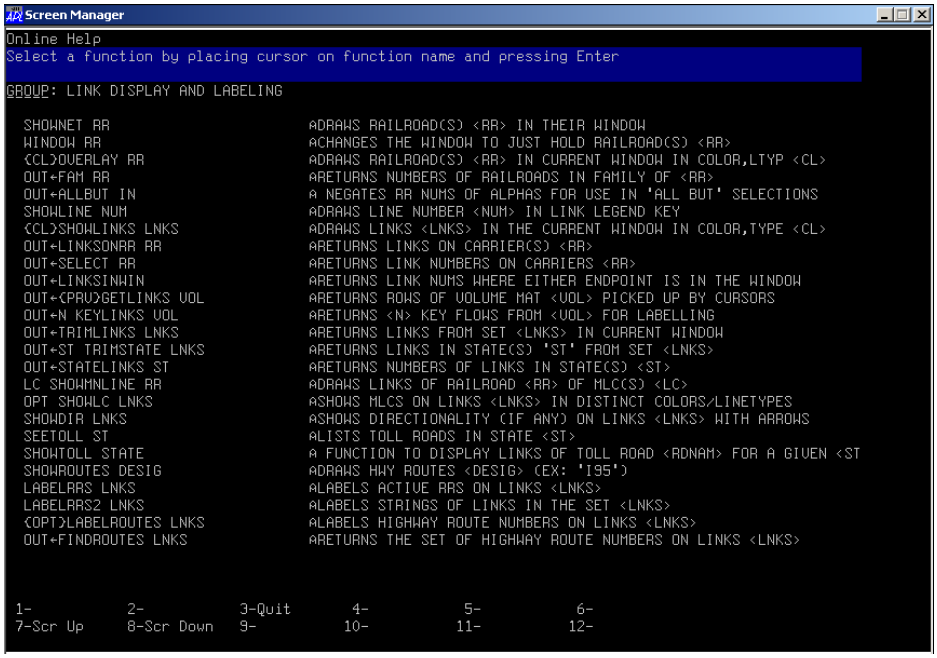
As a supplement to this manual, TRGRAPH contains complete on-line documentation. This section describes how to access the on-line documentation facility.

Remembering function names

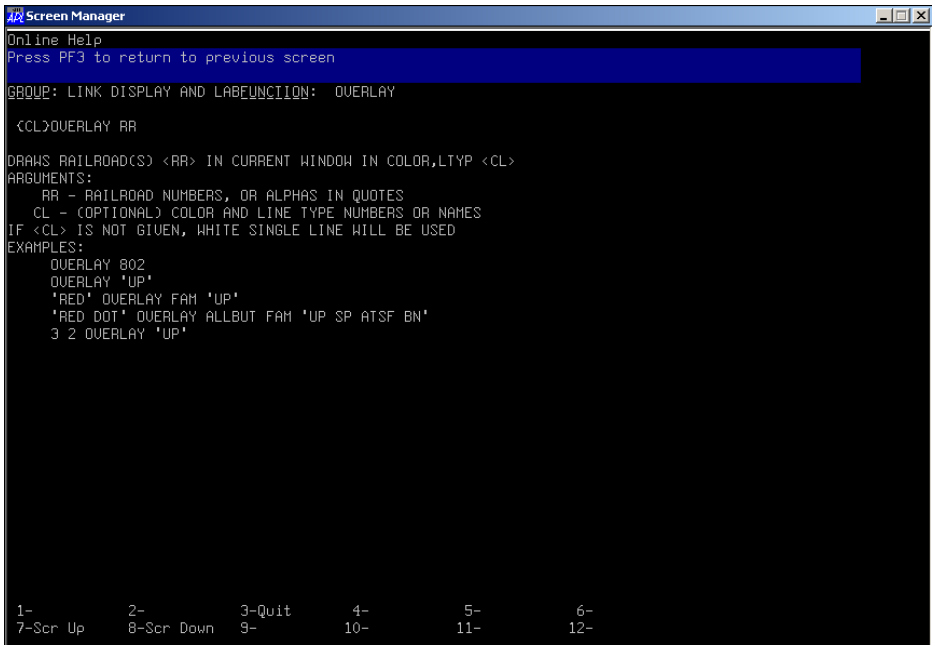
The function HELP serves as an on-line index to the functions in TRGRAPH. To use HELP, type in the command **HELP** and press ENTER. The following menu will come up on the screen:



To choose a group, place the cursor next to the desired group name and press ENTER. For this example, choose LINK DISPLAY AND LABELING. A panel of functions for the group chosen will appear as follows:


Screen Manager
Online Help
Select a function by placing cursor on function name and pressing Enter
GROUP: LINK DISPLAY AND LABELING
SHOWNET RR
WINDOW RR
{CL}OVERLAY RR
OUT=FAM RR
OUT=ALLBUT IN
SHOWLINE NUM
{CL}SHOWLINKS LNKS
OUT=LINKSONRR RR
OUT=SELECT RR
OUT=LINKSINWIN
OUT={PRV}GETLINKS VOL
OUT=N KEYLINKS VOL
OUT=TRIMLINKS LNKS
OUT=ST TRIMSTATE LNKS
OUT=STATELINKS ST
LC SHOWMNLINE RR
OPT SHOWLC LNKS
SHOWDIR LNKS
SEETOLL ST
SHOWTOLL STATE
SHOWROUTES DESIG
LABELRRS LNKS
LABELRRS2 LNKS
{OPT}LABELROUTES LNKS
OUT=FINDROUTES LNKS
ADRAWS RAILROAD(S) <RR> IN THEIR WINDOW
ACHANGES THE WINDOW TO JUST HOLD RAILROAD(S) <RR>
ADRAWS RAILROAD(S) <RR> IN CURRENT WINDOW IN COLOR,LTYP <CL>
ARETURNS NUMBERS OF RAILROADS IN FAMILY OF <RR>
A NEGATES RR NUMS OF ALPHAS FOR USE IN 'ALL BUT' SELECTIONS
ADRAWS LINE NUMBER <NUM> IN LINK LEGEND KEY
ADRAWS LINKS <LNKS> IN THE CURRENT WINDOW IN COLOR,TYPE <CL>
ARETURNS LINKS ON CARRIER(S) <RR>
ARETURNS LINK NUMBERS ON CARRIERS <RR>
ARETURNS LINK NUMS WHERE EITHER ENDPOINT IS IN THE WINDOW
ARETURNS ROWS OF VOLUME MAT <VOL> PICKED UP BY CURSORS
ARETURNS <N> KEY FLOWS FROM <VOL> FOR LABELLING
ARETURNS LINKS FROM SET <LNKS> IN CURRENT WINDOW
ARETURNS LINKS IN STATE(S) 'ST' FROM SET <LNKS>
ARETURNS NUMBERS OF LINKS IN STATE(S) <ST>
ADRAWS LINKS OF RAILROAD <RR> OF MLC(S) <LC>
ASHOWS MLCS ON LINKS <LNKS> IN DISTINCT COLORS/LINETYPES
ASHOWS DIRECTIONALITY (IF ANY) ON LINKS <LNKS> WITH ARROWS
ALISTS TOLL ROADS IN STATE <ST>
A FUNCTION TO DISPLAY LINKS OF TOLL ROAD <RDNAM> FOR A GIVEN <ST
ADRAWS HWY ROUTES <DESIG> (EX: 'I95')
ALABELS ACTIVE RRS ON LINKS <LNKS>
ALABELS STRINGS OF LINKS IN THE SET <LNKS>
ALABELS HIGHWAY ROUTE NUMBERS ON LINKS <LNKS>
ARETURNS THE SET OF HIGHWAY ROUTE NUMBERS ON LINKS <LNKS>
1- 2- 3-Quit 4- 5- 6-
7-Scr Up 8-Scr Down 9- 10- 11- 12-

The **PF7** and **PF8** keys will enable you to scroll through the functions for the specified group. Again, placing the cursor next to the function in question and pressing ENTER will display a detailed description of that function. For example, choosing the function OVERLAY will give the following information:


Screen Manager
Online Help
Press PF3 to return to previous screen
GROUP: LINK DISPLAY AND LABFUNCTION: OVERLAY
{CL}OVERLAY RR
DRAWS RAILROAD(S) <RR> IN CURRENT WINDOW IN COLOR,LTYP <CL>
ARGUMENTS:
RR - RAILROAD NUMBERS, OR ALPHAS IN QUOTES
CL - (OPTIONAL) COLOR AND LINE TYPE NUMBERS OR NAMES
IF <CL> IS NOT GIVEN, WHITE SINGLE LINE WILL BE USED
EXAMPLES:
OVERLAY 802
OVERLAY 'UP'
'RED' OVERLAY FAM 'UP'
'RED DOT' OVERLAY ALLBUT FAM 'UP SP ATSF BN'
3 2 OVERLAY 'UP'
1- 2- 3-Quit 4- 5- 6-
7-Scr Up 8-Scr Down 9- 10- 11- 12-

Detailed information on a function

The function SEE can be used to request detailed information on a particular function. SEE takes a function name in quotes as its right argument. For example, to get detailed information on the function ADDLINKS, type in:

```
SEE 'ADDLINKS'
```

In response to this command, the following information will appear on your screen:

```
RR ADDLINKS LNKS

ADDS LINK(S) <LNKS> TO RAILROAD <RR>
EXAMPLES:
'ATSF' ADDLINKS 256 2654 14526 15426 16542
22 ADDLINKS 17657
OPPOSITE OF THIS FUNCTION IS <DROPLINKS>
```

The same detailed function information is also accessible using HELP, as described in the preceding section.

Searching for a character string

The function FIND will search every function in TRGRAPH for a given character string, and will return a list of the names of functions containing that string. The character string may occur anywhere in the function except the comments. For example, to list all the functions containing the character string 'LINKS', type:

```
FIND 'LINKS'
```

FIND takes a relatively large amount of execution time and therefore should be used sparingly.

TRGRAPH Commands Reference

Introduction

This section gives a brief description of the TRGRAPH functions. The functions are grouped by subject and are shown in **boldface**. Function arguments and argument examples are shown in *italics*. Listed below are some of the common function arguments used in this section and their meanings.

Argument	Value
BEAS	Business Economic Area numbers
CL	color and/or line-type, index into MAPSETUP values
CMD	commodity flow group number
DESIG	highway road designation
FILE	file name or dataset name
FIPS	Federal Information Processing Standard code(s)
FORM	routing formula
FSAC	Freight Station Accounting Code(s)
LC	MLC code(s)
LNKS	link number(s)
MAT	data matrix
MSAS	Metropolitan Statistical Area code(s)
NAMES	country, state, city st, or county name
NDE	node number
NDES	node number(s)
OPT	special options
PC	pattern and/or color, index into MAPSETUP values
RR	Carrier number(s) or alpha(s)
SPLC	Standard Point Location Code number(s)
TABL	table
VOL	flow volume matrix
ZIPS	zip code number(s)

To request detailed information on a particular function, use the SEE function as described in this manual under the heading “Detailed information on a function”.

Functions for: Basic graphics

SWINDOW *W*	Sets Screen-window to (x-origin,x-range,y-origin,y-range)
VWINDOW *W*	Sets Virtual-window to (x-origin,x-range,y-origin,y-range)
QSWINDOW	Returns current screen window setting
QVWINDOW	Returns current virtual window setting
DRAW P	Draws triplets (flag, x-coordinate, y-coordinate)
SCURSOR	Returns (keynum,screen-x,screen-y) closest to cursor
VCURSOR	Returns (keynum, virtual-x,virtual-y) closest to cursor
REL2ABS *I*	Returns draw matrix I in absolute coordinates
ABS2REL *I*	Returns draw matrix I in relative coordinates
CONVS2V *I*	Returns draw matrix I in virtual coordinates
CONVV2S *I*	Returns draw matrix I in screen coordinates
ERASE	Erases the graphics screen (Mapping Window)

Functions for: Political boundaries (N. America)

USWINDOW	Sets window to just hold the United States
CANWINDOW	Sets window to just hold Canada
MEXWINDOW	Sets window to just hold Mexico
NAWINDOW	Sets window to just hold North America
STATEWINDOW *NAMES*	Sets window to just hold state(s) *NAMES* (Ex: *'NJ'*)
PROVWINDOW *NAMES*	Sets window to just hold province(s) *NAMES* (Ex: *'PQ'*)
ESTWINDOW *NAMES*	Sets the window to just hold Mexican state(s) *NAMES*
CNTYWINDOW *FIPS*	Sets window to hold counties *FIPS* (Ex: *'COOK IL'*)
USMAP	Draws US state boundaries
CANMAP	Draws Canadian province boundaries
MEXMAP	Draws Mexican state boundaries
NAMAP	Draws US, Canadian and Mexican state boundaries
COASTMAP	Draws US, Canadian and Mexican national borders
STATEMAP *NAMES*	Draws boundaries of states *NAMES* (Ex: *'NY,NJ')*
PROVMAP *NAMES*	Draws boundaries of provinces *NAMES* (Ex: *'ONPQ')*
ESTMAP *NAMES*	Draws boundaries of Mexican states NAMES
COUNTYMAP *NAMES*	Draws county boundaries of states *NAMES* (Ex: *'MA')*
CNTYMAP *FIPS*	Draws boundaries of counties *FIPS* (Ex: *'MERCER NJ')*
STATESINWIN	Returns FIPS codes for states in the current window
PROVINWIN	Returns codes for provinces in the current window
ESTINWIN	Returns codes for Mexican estados in the current window
STATELABEL *NAMES*	Labels states *NAMES* (Ex: *'NY'; 'US'* for all)
STLABEL *NAMES*	Labels states *NAMES* w/ abbreviation (Ex: *'NY'; 'US'* for all).
PROVLABEL *NAMES*	Labels provinces *NAMES* (Ex: *'PQ'; 'CN'* for all)
ESTLABEL *NAMES*	Labels Mexican states *NAMES* (Ex: *'SO'; 'MX'* for all)
COUNTYLABEL *NAMES*	Labels counties in states *NAMES* (Ex: *'CA'*)
CNTYLABEL *FIPS*	Labels counties given by *FIPS* Code(s) or *(CNTY, ST)*
STATEBNDS *NAMES*	Returns draw mat for state(s) *NAMES* (Ex: *'NYNJ')*
PROVBNDS *NAMES*	Returns draw mat for province(s) *NAMES* (Ex: *'ONPQ'*)
ESTBNDS *NAMES*	Returns draw mat for Mexican estados *NAMES* (Ex: *'SO,BN')*
COUNTYBNDS *NAMES*	Returns draw mat for counties in states *NAMES*
CNTYBNDS *FIPS*	Returns draw mat for counties *FIPS* or *(county,st)*
STATEOUTLIN *NAMES*	Returns draw mat outline of state(s) *NAMES*
PROVOUTLIN *NAMES*	Returns outline for province(s) *NAMES* (Ex: *'ONPQ'*)
ESTOUTLIN *NAMES*	Returns outline for estado(s) *NAMES* (Ex: *'MX'*)
CNTYOUTLIN *FIPS*	Returns draw mat for outline of counties *FIPS*
STATE∆FIPS *NAMES*	Returns FIPS code for states *NAMES* (Ex: *'NYNJ'*)

FIPS∆STATE *FIPS*	Returns 2-letter state abbreviation for *FIPS*
COUNTY∆FIPS *CNTY*	Returns FIPS for (county, state) (Ex: *'MERCER NJ'*)
FIPS∆COUNTY *FIPS*	Returns county name for 5-digit *FIPS*
FIPS∆STNAM *FIPS*	Returns state name for 2-digit *FIPS*
STNAM∆FIPS *NAMES*	Returns FIPS code for states *NAMES* (Ex: *'MAINE'*)
GETSTRINGS *MAT*	Returns draw mat strings from *MAT* picked by cursors
USMAPLOAD	Reads in US map variables from disk
CANMAPLOAD	Reads in Canadian map variables from disk
MEXMAPLOAD	Reads in Mexican map variables from disk
MEXMAPUNLOAD	Erases Mexican map variables from workspace
USMAPUNLOAD	Erases US map variables from workspace
CANMAPUNLOAD	Erases Canadian map variables from workspace
LONGITUDE *N*	Returns draw matrix for longitude(s) *N*
LATITUDE *N*	Returns draw matrix for latitude(s) *N*
ALBERS *IN*	Returns (x,y) for (latitude,longitude) *IN*

Functions for: BEAS, SPLCS

BEAMAP	Draws BEA (Business Economic Area) boundaries
BEALABEL *BEAS*	Labels *BEAS* (0 for all) with BEA numbers
BEABNDS *BEAS*	Returns draw matrix for BEA(s) *N*
BEAOUTLIN *BEAS*	Returns draw matrix outline of *BEAS*
FIPS∆BEA *FIPS*	Returns BEA number(s) for given *FIPS* codes
BEA∆NAME *BEA*	Returns name(s) for *BEA(s)*
BEAMAPLOAD	Reads in BEA map variables from disk
BEAMAPUNLOAD	Erases BEA map variables from workspace
SPLC∆FIPS *SPLC*	Returns FIPS county code(s) for 4-digit *SPLC*
SPLC2FIPS *SPLC*	Returns 2-digit FIP(s) for 2-digit *SPLC*
TSPLC *NAME*	Returns the 2-digit SPLC(s) for the state or prov *NAME*
SPLCOUTLIN *N*	Returns outline of 1, 2, 3 or 4-digit SPLC areas *N*
SPLCBNDS *N*	Returns internal boundaries at next level for SPLC areas *N*
FIPS∆SPLC *FIPS*	Returns 4-digit SPLCs for county name(s) or *FIPS* code(s)

Functions for: Legends, keys, panes, borders, and scales

MAPDEFAULT *N*	Sets default map parameters for plot factor *N*
MAPSETUP	Accepts changes in legend parameters via menu
BLANKLEGEND	Blanks out area of the screen for the legend
SHOWLEGEND	Draws legend box according to parameters from MAPSETUP
LEGENDBOX	Returns draw matrix for legend box outline
LDRAW *EX*	Executes function *EX* with no drawing in legend corner
BORDER	Draws a border around the edge of the S-window
LBORDER	Draws a border around the screen area to be shown by LDRAW
BORDERLINE	Returns draw matrix to outline current S-window
LBORDERLINE	Returns draw mat to outline screen area to be shown by LDRAW
USBORDER	Draws a border around the US map in proportions 11x17
SAVEMAP *NAME*	Saves MAPSETUP values on disk under *NAME*
LOADMAP *NAME*	Reads in MAPSETUP values called *NAME* from disk
LISTMAP	Lists MAPSETUP value files saved on disk
N **CHTEXT** *PHRASE*	Changes line(s) *N* of legend text to *PHRASE*
BESTCORC *C*	Returns num of best legend corner to avoid virtual coordinates *C*
LOCATELEGEND *CORN*	Places legend in corner *CORN*
BESTCORNER *LNKS*	Returns num of best legend corner to avoid *LNKS*
SIZELEGEND	Resizes legend box to accommodate current parameter settings
FULLWINDOW	Sets S-window to full screen
A **MWINDOW** *B*	Sets V-window as *B* with shrinkage factor *A*
FLIPAREA	Show the area to be flipped using FLIPON
FLIPON	Initiates flipping of map sideways on screen
FLIPOFF	Turn offs screen flipping
FLIPDECIDE *C*	Turns flipping on or off to best show coords *C*
SHAPE *V*	Returns V-window V reshaped to match S-window w/o distortion

Functions for: Reading networks in and out

PICKNET	Lets user pick and load a network from those available
LISTNET	Lists networks saved on disk
LOADNET *NAME*	Reads in network *NAME* from disk
SAVENET	Saves network with user menu
NETUNLOAD	Erases network variables from workspace

Functions for: Link display and labeling

SHOWNET *RR*	Draws carrier(s) *RR* in their window
WINDOW *RR*	Changes the window to just hold carrier(s) *RR*
CL **OVERLAY** *RR*	Draws carrier(s) *RR* in current window (using color CL)
FAM *RR*	Returns numbers of carriers in family of *RR*
ALLBUT *RR*	Returns all carriers except *RR*
CL **SHOWLINE** *NUM*	Draws line number *NUM* in link legend key in (color,line-type) *CL*
CL **SHOWLINKS** *LNKS*	Draws link numbers or node pairs *LNKS* in (color, line-type) *CL*
LINKSONRR *RR*	Returns link numbers on carriers *RR* irregardless of window
SELECT *RR*	Returns link numbers on carriers *RR* in current window
LINKSINWIN	Returns link numbers where either endpoint is in the window
PRV **GETLINKS** *LNKS*	Returns LNKS selected using cursors
NUM **KEYLINKS** *LNKS*	Returns *NUM* most important links from set *LNKS*
TRIMLINKS *LNKS*	Returns links from set *LNKS* in current window
ST **TRIMSTATE** *LNKS*	Returns link numbers in states *ST* from set *LNKS*
STATELINKS *ST*	Returns links in state(s) *ST* (Ex: *'NJ'*)
LC **SHOWMNLINE** *RR*	Draws links of carrier *RR* of MLC(s) *LC*
OPT **SHOWLC** *LNKS*	Shows MLCs on LNKS using colors/line-types *OPT*
SHOWDIR *LNKS*	Shows directionality (if any) on links *LNKS* with arrows
SEETOLL *ST*	List toll roads in state *ST*
SHOWTOLL *ST*	Displays links of toll roads for a given *ST*
SHOWROUTES *DESIG*	Draws hwy routes *DESIG* (Ex: *'I95'*; 'I'; 'US50')
LABELRRS *LNKS*	Labels active carriers on each link in *LNKS*
LABELRRS2 *LNKS*	Labels active carriers on each string of links in *LNKS*
OPT **LABELROUTES** *LNKS*	Labels highway route numbers on *LNKS* using text
FINDROUTES *LNKS*	Returns highway route numbers on links *LNKS*
LABELDIST *LNKS*	Labels distances on *LNKS*
LABELINKS *LNKS*	Labels link numbers of links *LNKS*
NODES2LINKS *NDES*	Returns link numbers for node pairs *NDES*
MILES **NDECLEAN** *NDERR*	Returns (node,carrier) pairs with *NDERR* cleaned up to be on the carrier within *MILES*
CHECKRR *RR*	Returns number(s) of *RR* if valid
OPT **CHLINKS** *NDES*	Returns all links connected to *NDES*
RRSON *LNKS*	Returns numbers of carriers on each of *LNKS*

RRSON2 *LNKS*	Returns set of numbers of carriers on any of *LNKS*
FINDRRS *LNKS*	Returns the set of carrier alphas on *LNKS*
RR∆ALPHA *RR*	Returns carrier alphas for carrier(s) *RR*
RRFOR *ALPH*	Returns carrier numbers for alphas *ALPH*
N **KEYROUTES** *LNKS*	Returns *N* key links for labeling with route numbers from *LNKS*
ROUTELINKS *DESIG*	Returns links for routes in *DESIG* (Ex: *'I95')*
LC **MLCLINKS** *RR*	Returns links of *LC* on carrier *RR*
SEGMENT *LNKS*	Returns aggregated segment information (segnum,link,a,b) for *LNKS*

Functions for: Node display and labeling

SHOW *NDES*	Outputs number(s) of *NDES* at their locations
LABEL *NDES*	Outputs city names at the locations of *NDES*
NDES **NLABEL** *LNKS*	Labels *NDES* avoiding links *LNKS*
LABELCITIES *RR*	Labels approx 15 key cities on carrier(s) *RR*
N **KEYCITIES** *LNKS*	Returns *N* most important nodes on links *LNKS*
SHOWNODES *NDES*	Places a triangle at location of *NDES*
NODESINWIN	Returns numbers of nodes in current window
TRIMNODES *NDES*	Returns nodes from set *NDES* in current window
NWINDOW *NDES*	Changes the window to just hold node(s) *NDES*
PRV **GETNODES** *NDES*	Returns nodes from set *NDES* selected by cursor
NODESONRR *RR*	Returns numbers of nodes on carrier(s) *RR*
RRSAT *NDES*	Returns numbers of carriers operating at *NDES*
NODEPAIRS *LNKS*	Returns 2-col matrix (anode,bnode) for links *LNKS*
RIV **MP** *MPST*	Returns node number for milepost *MPST* on river *RIV*
OPT **CHLINKS** *NDES*	Returns all links connected to *NDES*
CHOOSE *NDES*	Returns nodes connected directly by links to *NDES*
GETNODES *NDES*	Allows cursor identification and selection of nodes from set *NDES*
GETNAMES *NDES*	Returns (city,st) for node(s) *NDES*
CODE **NAMESFOR** *NDE*	Returns node attributes or just city, state for *NDE* depending on value of *CODE*
NODEFOR *NAMES*	Returns node number(s) for (city,st) *NAMES*
SPLCFOR *NAMES*	Returns SPLC number(s) for (city,st) *NAMES*
SPLC∆NAME *SPLC*	Returns name(s) for SPLC(s) (Ex: *SPLC∆NAME 380000*)
SPLC∆NODE *SPLC*	Returns node number(s) for 6-digit *SPLC*
SPLC2NODE *SPLC*	Returns node number(s) for 6-digit *SPLC* with cleanup
NODE2SPLC *NDES*	Returns representative 2-digit SPLC for *NDES*
READSPLC *SPLC*	Returns records from disk file for 4-digit *SPLC*
READSPLC2 *SPLC*	Returns records from disk file for 2-digit *SPLC*
FSAC2NODE *FSAC*	Returns node numbers for *FSACs*
FSAC2SPLC *FSAC*	Returns SPLCs for *FSACs*
FSAC2NAME *FSAC*	Returns names for *FSACs*
SHOWJCT *NDES*	Displays Rule 260 junction codes at *NDES*
JCT∆NODE *JCTS*	Translates Rule 260 junction codes *JCTS* (Ex: *'CHGO'*) to nodes
INT **CONCIRC** *NDE*	Draws concentric circles at distance interval *INT* around *NDE*

Functions for: Zooming in and windowing

ZOOM	Use cursors to define area to be enlarged
RETREAT	Enlarges V-window area by a factor of 2
ADVANCE	Shrinks V-window area by a factor of 2
PER **BACKWINDOW** *CORN*	Increases window *PER* percent in corner *CORN*

Functions for: Minimum path routing

RR **FORMNET** *FORM*	Sets up carrier *RR* with impedance formula *FORM*
BESTROUTE	Returns impedance formula for "best route"
SHORTROUTE	Returns impedance formula for "shortest" route
MINPATH *NDES*	Calculates the minimum path tree from node(s) *NDES*
ROUTE *N*	Return impedance formula for "actual" route according to row *N* of MLC matrix
PATH *NDES*	Draws the path to node(s) *NDES*
SHOWPATH	Draws the entire minimum path tree
PATHNODES *NDES*	Returns predecessor nodes from *NDES*
PATHLINKS *NDES*	Returns links along path(s) to *NDES*
PATHVIA *NDE*	Shows the links served via *NDE* from treesource
NODESVIA *NDE*	Returns nodes reached via *NDE* from treesource
LINKSVIA *NDE*	Returns links reached via *NDE* from treesource
PATHDIST *NDES*	Places name and distance from treesource at *NDES*
PATHLIST *NDE*	Lists route from treesource to *NDE* in menu
CHECKCONNECT	Returns disconnected nodes from the last MINPATH
NDES **GETSUM** *FORM*	Returns sum of *FORM* to each of *NDES*
GETORIG *NDES*	Returns origin node on tree for each of *NDES*
MPUNLOAD	Erases the global variables created by MINPATH

Functions for: Link volume display

LISTVOL	Returns list of volume files saved on disk
RR **GETVOL** *FILE*	Returns volumes for *RR* from flow file *FILE*
VOLSTATS *VOL*	Lists certain information about *VOL*
CMD **SHOWFLOWS** *VOL*	Draws volumes from 2-column group *CMD* of matrix *VOL*
CMD **SHOWFLOWSΔDOT** *VOL*	Draws volumes from 2-column group *CMD* of matrix *VOL* in dots
CMD **SHOWKEY** *VOL*	Draws volume key in legend
CMD **SHOWFLOWSΔMULT** *VOL*	Draws volume from group *CMD* around lower-number groups
CMD **SHOWFLOWMAX** *VOL*	Draws the greater volume on links in *VOL*
CMD **SHOWFLOWMIN** *VOL*	Draws the lesser volume on links in *VOL*
CMD **FLOWLINKS** *VOL*	Draws links of non-zero flows for grp *CMD* of matrix *VOL*
PRV **GETLINKS** *VOL*	Returns rows of volume mat *VOL* selected by cursors
VOL **LINKMATCH** *LVOL*	Extracts from *VOL* those links in *LVOL*
CMD **LABELFLOWS** *VOL*	Labels volumes from 2-col group *CMD* of mat *VOL*
CMD **LABELFLOWSΔMULT** *VOL*	Labels volumes from group *CMD* around lower-number group
CMD **FILLFLOWS** *VOL*	Fills volumes from 2-col group *CMD* of matrix *VOL*
CMD **SHOWKEYFILL** *VOL*	Fills volume key in legend
CMD **FILLFLOWMAX** *VOL*	Fills the greater volume on links in *VOL*
CMD **FILLFLOWMIN** *VOL*	Fills the lesser volume on links in *VOL*
CMD **FILLFLOWSΔMULT** *VOL*	Fills vols from group *CMD* outside lower-numbered groups
CMD **SMOOTHFLOWS** *VOL*	Smoothes out filled flows by filling in gaps
N **CUTVOL** *VOL*	Returns *VOL* cut back to highest *N* links
MIN **CUTVOL2** *VOL*	Returns *VOL* cut back to one-way volumes greater than or equal to *MIN*
MIN **CUTVOL3** *VOL*	Returns *VOL* cut back in continuous segments
PCT **CUTVOL4** *VOL*	Returns *VOL* cut back to one-way volumes greater than *PCT* of maximum one-way volume of any flow group in *VOL*
TRIMVOL *VOL*	Returns *VOL* trimmed to only links in window
AGGVOL *IN*	Aggregates identical volumes in *IN* on adjoining links
PARM **AGGVOL2** *VOL*	Aggregates *VOL* according to parameters *PARM*
BMAT **GETCHANGE** *AMAT*	Returns volume gains and losses by comparing *BMAT* and *AMAT*

Functions for: Pie charts

PIFORM∆NODE *MAT*	Assigns coords to (Node,values) matrix *MAT*
PIFORM∆FIPS *MAT*	Assigns coords to (FIPS,values) matrix *MAT*
PIFORM∆SPLC *MAT*	Assigns coords to (SPLC,values) matrix *MAT*
PIFORM∆STATE *MAT*	Assigns coords to (state/prov,values) matrix *MAT*
PIFORM∆BEA *MAT*	Assigns coords to (BEA,values) matrix *MAT*
PIFORM∆GRAPH *MAT*	Assigns coords to non-geographic matrix*MAT*
COORD **PIFORM** *MAT*	Assigns coords using *COORD* to (location,values) matrix *MAT*
PICHART *XYV*	Draws pie and slice outlines using data in matrix *XYV*
SLICE **PIFILL** *XYV*	Fills in slice(s) number *SLICE* of piechart matrix *XYV*
PIKEY *XYV*	Places scale pies and labels in legend
SLICE **PIKEYFILL** *XYV*	Fills slice(s) *SLICE* in pie chart map legend
PIVALUE *XYV*	Places value next to each pie slice
NAMES **PILABEL** *XYV*	Places *NAMES* below each pie in *XYV*
N **PILABEL∆NODE** *MAT*	Labels top *N* node numbers in *MAT*[;1] by volume in *MAT*[;2 3....]
L **PILINKS** *MAT*	Returns draw mat for links *L* trimmed around pies *MAT*
TRIMXY *MAT*	Returns (x,y,values) *MAT* trimmed to those points in window
PIEDIT *XYV*	Returns piformed *XYV* with centers moved by cursors
AGG **GENAGG** *MAT*	Aggregates matrix *MAT* using cursors
FILLKEY	Draws the key and ids on a non-geographic chart
FILLBOX *N*	Fills in key on a non-geographic chart
SHOWTITLE	Places title at the top center of the screen

Functions for: Bar charts

BARFORM∆NODE *MAT*	Assigns coords to (Node,values) matrix *MAT*
BARFORM∆FIPS *MAT*	Assigns coords to (FIPS,values) matrix *MAT*
BARFORM∆SPLC *MAT*	Assigns coords to (SPLC,values) matrix *MAT*
BARFORM∆STATE *MAT*	Assigns coords to (state/prov,values) *MAT*
BAFFORM∆BEA *MAT*	Assigns coords to (BEA,values) matrix *MAT*
BARFORM∆GRAPH *MAT*	Assigns coords to non-geographic matrix *MAT*
COORD **BARFORM** *MAT*	Assigns coords using *COORD* to (location,values) matrix *MAT*
BARCHART XYV	Draws bar outlines using data in matrix *XYV*
I **BARFILL** *XYV*	Fills share or (share,bar) *I* of barchart matrix *XYV*
BARKEY *XYV*	Draws the legend key for barchart matrix *XYV*
BARVALUE *XYV*	Places value at top of each bar
NAMES **BARLABEL** *XYV*	Places *NAMES* below each group of bars
BARSCALE *XYV*	Draws a left-hand scale for non-geographic bar charts
FILLKEY	Draws the key and ids on a non-geographic chart
FILLBOX *N*	Fills in key on a non-geographic chart
INT **BARGROUP** *MAT*	Returns observations *MAT* grouped into intervals *INT*
INT **BARRANGE** *MAT*	Draws a range scale below each group of bars in *MAT*
TRIMXY *MAT*	Returns (x,y,values) *MAT* trimmed to those points in window
BAREDIT *XYV*	Returns barformed *XYV* with centers moved by cursors
SHOWTITLE	Places title at the top center of the screen

Functions for: Network editing

OPT **CREATENET** *NAME*	Initializes variables for a new network *NAME* using *OPT*
LINKEDIT *LNKS*	Lets user edit link attributes of *LNKS* using menu
SHPEDIT *LNKS*	Lets user edit shape points for links *LNKS* using menu
NODEEDIT *NDES*	Lets user edit node attributes of *NDES* using menu
OUT **MERGE** *IN*	Merges carriers *IN* as carrier *OUT*
FAMILIZE *RR*	Creates a carrier family from carriers *RR*
DEFAMILIZE *RR*	Eliminates the family composed of carriers *RR*
ADDRR *RR*	Adds carrier *RR* to the network
RR **ADDLINKS** *LNKS*	Adds *LNKS* to carrier *RR*
RR **DROPLINKS** *LNKS*	Deletes *LNKS* from carrier *RR*
RR **ADDNEWLINK** *NDES*	Creates a new link on *RR* between pairs of *NDES*
RR **BUILDLINKS** *LNKS*	Construct links and nodes using etch-a-sketch
SPLITLINK *NUM*	Splits link number *NUM* at point entered using cursor
ASSIGNDIST *LNKS*	Assigns distance to links *LNKS* based on straight-line
ADDNEWNODES	Lets user add new nodes using cursor
LC **CHMLC** *LNKS*	Changes MLC on links *LNKS* to value *LC*
NDES **CHANGENAME** *PHRS*	Changes name(s) of *NDES* to (city,st) *PHRS*
LOCATE *NDE*	Relocates *NDE* by calling up the cursors
CHANGECOORD	Change node locations using cursor input
LASSO *NDES*	Returns nodes from *NDES* within a user-created area
PRV **CLOSEST** *NDES*	Returns node from set *NDES* closest to graphics cursor
JCTS **CHANGEJCT** *NDES*	Changes the node number assigned to the given Rule 260 junction code *JCTS* to *NDES*
SPLC **CHANGESPLC** *NDE*	Changes the node number assigned to the given *SPLC* to *NDE*
NETMAT *NAME*	Returns COORD and LINKS in window for network *NAME*
CL **NETDRAW** *NETMAT*	Draws all links in NETMAT (coord,links) in (color, line-type) *CL*

Functions for: MapMaker

MAPMENU	Places user in MapMaker menu system
OLDP **MAPBAR** *NEWP*	Draws/redraws a bar chart map
OLDP **MAPCARRIER** *NEWP*	Draws/redraws a carrier map
OLDP **MAPFLOW** *NEWP*	Draws/redraws a single flow traffic density chart
OLDP **MAPFLOWCHNG** *NEWP*	Draws/redraws a traffic density chart of changes in flow
OLDP **MAPFLOWMULT** *NEWP*	Draws/redraws a traffic density chart of multiple stacked flows
OLDP **MAPNET** *NEWP*	Draws/redraws a network map
OLDP **MAPPIE** *NEWP*	Draws/redraws a pie chart map
OLDP **MAPROUTE** *NEWP*	Draws/redraws a route map
OLDP **MAPSHADE** *NEWP*	Draws/redraws a shaded area map
DFLTBAR	Returns defaults for a bar chart map
DFLTCARRIER	Returns defaults for a carrier map
DFLTFLOW	Returns defaults for a single flow traffic density chart
DFLTFLOWCHNG	Returns defaults for a traffic density chart of changes in flow
DFLTFLOWMULT	Returns defaults for a multiple flow traffic density chart
DFLTNET	Returns defaults for a network map
DFLTPIE	Returns defaults for a pie chart map
DFLTROUTE	Returns defaults for a route map
DFLTSHADE	Returns defaults for a shaded area map
MAPERASE *N*	Conditionally erases all or part of the screen
SAVEMAP *NAME*	Saves MAPSETUP values on disk under *NAME*
LOADMAP *NAME*	Reads in MAPSETUP values called *NAME* from disk

Functions for: Communication with your operating system

READARR *FILE*	Reads contents of *FILE* into a general array
ARRAY **WRITEARR** *FILE*	Writes any APL *ARRAY* into *FILE*
VARS **LOADVARS** *FILE*	Reads in variables saved in disk file *FILE*
VARS **SAVEVARS** *FILE*	Writes variables *VARS* to file *FILE*
READFIX *FILE*	Reads in a fixed-length character *FILE*
IN **WRITEFIX** *FILE*	Writes character matrix *IN* as a fixed length *FILE*
FILE **PARTSHR** *PARMS*	Opens/closes *FILE* for reading or writing
VAR **PARTPROC** *PARMS*	Reads/writes data to/from file opened using PARTSHR
DASHR *PARMS*	Opens/closes a disk file for reading or writing
OUT **DAPROC** *PARMS*	Reads or writes records from a file opened using DASHR
SL **READSOME** *FILE*	Reads in certain records of a fixed-length disk file *FILE*
COND **READCOND** *FILE*	Reads records from *FILE* which meet conditions *COND*
COLS **READFIXCOLS** *FILE*	Reads columns *COLS* of fixed-length *FILE*
FW **CHAR2NUM** *MAT*	Converts character matrix *MAT* to numbers with field widths *FW*
CHAR∆TO∆NUM *MAT*	Changes character-stored matrix *MAT* to numerical
EXISTFILE *FILE*	Returns a 1 if disk file *FILE* exists, o if not
GETDISK *NAME*	Returns file NAME with disk
RECSINFILE *FILE*	Returns the number of logical records in *FILE*

Functions for: Advanced graphics capabilities

L **LTYP** *MAT*	Returns draw matrix *MAT* with flags for line-type fill pattern *L*
CLR **COLOR** *MAT*	Assigns color *CLR* to draw matrix MAT
SETCOLOR *CLR*	Sets the override color *CLR* or " to reset defaults
NOSTORE *MAT*	Returns draw matrix *MAT* with flags for write-thru image
MOVING *MAT*	Returns draw matrix *MAT* with flags for movable image
DEFOCUS *MAT*	Returns draw matrix *MAT* with flags for defocused image
PANEL *MAT*	Returns draw matrix shaded in
OVERLAP *MAT*	Returns draw matrix with flag for filled overlap
PORDER ***MAT***	Returns draw matrix for continuous ordered filling, also converts to virtual coordinates
NOPORDER *MAT*	Returns draw matrix *MAT* indicating that triplets are already ordered for filling
FILLORDER *MAT*	Returns draw matrix *MAT* with triplets ordered for filling
PTS **PUTCHAR** *WORDS*	Places *WORDS* at v-coord *PTS*
SCL **TRIANGLE** *PTS*	Returns draw mat of Δ's size(s) *SCL* at v-coord *PTS*
SCL **SQUARE** *PTS*	Returns draw mat of squares size(s) *SCL* at v-coord *PTS*
SCL **OCTAGON** *PTS*	Returns draw mat of O's of size(s) *SCL* at v-coord *PTS*

Functions for: Hard copy

PRINT_MAP *PRTNAME*	Sends contents on Mapping Window to printer *PRTNAME*
PRINTER_SELECT	Lets user select printer from list of attached printers
PSON *FILE*	Initializes trapping graphic in Postscript file *FILE*
PSOFF	Closes Postscript file
PSPROMPT	Prompts user for file name for PSON

Functions for: Utility subroutines

COLS **SORT** *IN*	Returns char or num matrix *IN* sorted by columns *COLS*
A **INORDERAS** *B*	Returns indices to put vector *A* in the same order as *B*
COLS **SUMDATA** *IN*	Returns *IN* summed over like records of *IN[;COLS]*
STRIP *ARRAY*	Strips trailing blanks/zeros from *ARRAY*
IN **ADDTOMAT** *ROW*	Adds vector or matrix *ROW* to mat *IN*, padding as necessary
A **EXPAND** *B*	Returns *B* expanded by frequencies *A*
IOTA *FREQ*	Returns concatenation of frequency *FREQ* where *FREQ* is a vector
NUMS **IOTAPLUS** *FREQ*	Returns *-1+NUMS+ FREQ* where *NUMS* and *FREQ* are vectors
A **CENTER** *B*	Returns *B* centered in character array of dimensions *A*
INDIV *B*	Returns the set of unique elements of vector or matrix *B*
B **DISTANCE** *A*	Returns cartesian distance between (X,Y) *A* and *B*
CHAR **CH∆CHAR** *MAT*	Changes all blanks in *MAT* to *CHAR*
ALPHADEX *ALPHAS*	Returns indices into alphabet for *ALPHAS*
DATATYPE *IN*	Returns data type of *IN* (0=numerical, 1=character)
STORTYPE *VAR*	Returns type of *VAR* (1=char, 2=log, 3=int, 4=real)
EXISTFILE *FILE*	Returns a 1 if disk *FILE* exists, 0 if not
EXISTVAR *VAR*	Returns logical vector telling if variable(s) *VAR* exist
EXISTFN *FN*	Returns logical vector telling if function(s) *FN* exist
STR **LOOKFOR** *LIST*	Returns a '1' if string *STR* is in *LIST*
CHAR **PADIT** *MAT*	Converts lead, trail, and double blanks in *MAT* to *CHAR*
CHAR **PARSE** *V*	Parses vector *V* with delimiter(s) *CHAR*
SCL **PLACE** *OUT*	Types variable *OUT* on the graphics screen at size *SCL*
CAP *IN*	Returns phrase *IN* with first letter of each word capitalized
UNCAP *IN*	Returns upper case matrix *IN* as mixed upper/lower case
ALLCAP *IN*	Returns character array *IN* with all capital letters
ALLUNCAP *IN*	Returns character array *IN* uncapitalized
UNUND *IN*	Turns all underlined chars in *IN* to upper case
STCC∆NAME *IN*	Translates 2-5 digit STCC codes to names

Functions for: User-written functions

LOADFN *NAME*	Reads in function *NAME* (Ex: *'MYMAP'*)
SAVEFN *NAME*	Saves function *NAME* on disk (Ex: *'MYMAP'*)
LOADPKG *PKG*	Loads package *PKG* into the workspace and executes its latent expression
LST **SAVEPKG** *PKG*	Saves contents of *LST* as package *PKG* on disk

Functions for: Documentation and help facility

HELP	Requests help for functions by group
SEE *FN*	Prints header and leading comments in function *FN*
LIST *FNS*	Returns list of functions in mat *FNS* with description
FIND *NAME*	Returns names of functions containing character string *NAME*